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REPORT

OF THE

MIDNAPORE AND BURDWAN CYCLONE

OF THE

15TH AND 16TH OF OCTOBER 1874.

BY

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REPORT

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15th and 16th October 1874.

I PROPOSE in the first place to give a general review of the meteorology of Bengal and the Bay for some days before the storm. Next, to consider the progress of the cyclone in the Bay of Bengal; then, in order, its passage over the Sandheads, the Midnapore, Burdwan, and Moorshedabad districts, and its final disappearance. Any remarks or conclusions regarding the general laws of cyclones which may appear to be borne out by the storm under report will form the subject of the last section. Each part will commence with a record and description of the data which are at my disposal, and the remarks which I have to make will follow.

Before entering upon the discussion of the meteorological phenomena which preceded and accompanied the cyclone, it may be well to describe in a few words the general course which it pursued. The centre of the cyclone, moving in a north-north-westerly direction, passed over the Sandheads about noon of the 15th. It was nearest to Saugor Island about 5 P.M., and struck the coast-line about Long. 87° 37′ E. Near Midnapore the course of the cyclone re-curved. The centre passed about 15 miles to the east of that place between midnight and 1 A.M. of the 16th, and the vortex passed over the town of Burdwan between 6 and 7 in the morning. Between 1-15 and 3 of the afternoon of the same day the central calm was passing over the town of Berhampore, the storm having then greatly diminished in violence. The centre after this followed a more easterly path, passing to the westward of Bogra, about 10 P.M., and over the junction of the Teesta and Brahmapootra, about 2 A.M. of the 17th. The storm finally broke up on the western ridge of the Garo Hills, approaching, but not reaching, Goalpara in Assam. The diameter of the body of the hurricane was, in round numbers, about 50 miles; but outside this circumference, especially on the eastern side, a heavy gale of wind extended to some distance.

SECTION I.

DATA.

Descriptions of Tables.

The following tables are compiled from the Government meteorological registers kept at several stations in Bengal and round the Bay. They are intended to illustrate the variations of the principal meteorological elements for some days before, and during the passage of, the storm. More detailed observations, which were made at certain places during the progress of the storm, will be given in subsequent sections.

Table I.—Where four observations are given, the wind directions are those recorded at 4*h*., 10*h*., 16*h*., and 22*h*. on each day. Where only two observations appear, they are those made at 10*h*. and 16*h*. The diurnal velocity of wind is given in miles per 24 hours, from 16*h*. to 16*h*.

Table II.—The mean atmospheric pressures, reduced to the temperature 32° F., and also reduced to sea-level, are shown for several stations from the 7th to the 18th October. In the case of Madras, Port Blair, and Nancowry (Nicobar Islands), the pressures given are the arithmetic means of the 10*h*. and 16*h*. observations. For Akyab, Chittagong, Dacca, Calcutta, Saugor Island, Cuttack, False Point, and Vizagapatam, the pressures are the arithmetic means of the observations taken at 4*h*., 10*h*., 16*h*., and 22*h*. For the remaining stations the mean pressures have been deduced by applying to the 10*h*. and 16*h*. observations corrections obtained from the registers of preceding years. In order to compare the different atmospheric gradients about the time when the cyclone was in process of formation with the normal gradients for the time of year, the mean pressures for the 10th October, deduced from several years observations, are given in the last column. All the barometric data, except those for Madras, are corrected to the Calcutta standard, which reads 0·011 higher than that of Kew.

The mean temperatures shown are not reduced to sea-level. In the case of Akyab, Chittagong, Dacca, Calcutta, Saugor Island, Cuttack, False Point, and Vizagapatam, the mean temperatures as given are the arithmetic means of observations taken at 4*h*., 10*h*., 16*h*., and 22*h*. For the other stations, with the exceptions specified in the foot-note, the mean temperatures are derived from the maximum and minimum temperatures by applying corrections obtained empirically from the registers of past years. The final column also shows the normal mean temperatures for the 10th October, deduced from the observations of some years.

Table III.—The pressures recorded at 10*h*. and 16*h*., which are approximately the maximum and minimum diurnal pressures, are shown for several stations for the period from the 7th to the 18th, and also the rise or fall since the same hour of the previous day. The observations are all reduced to the temperature 32° F., but are not reduced to sea-level. The elevation of the barometer cistern at Hazareebagh above sea-level is 1,996 feet. The elevations, however, are not required for this table, which is intended merely to exhibit variations of pressure. The elevations of the barometers at the other stations are shown in Table II.

Table IV.—The humidities are calculated, from the observations of the dry and wet bulb thermometers, by August's formula modified by Regnault, saturation being taken as 100. For the stations to which reference is made in the note at the foot of the table the humidities shown are the arithmetic means of the observations made at 10*h*. and 16*h*., and are hence not true means, but they are sufficient to show variations. For the remaining stations the humidities

given are the arithmetic means of observations recorded for 4*h*., 10*h*., 16*h*., and 22*h*. The normal humidities for the month of October, given in the last column, are derived from five years' observations, and, except in the case of Madras and Port Blair, are all true means. For these latter stations, they are the means of 10*h*. and 16*h*. observations.

Table V.—This table shows the daily rainfall from the 7th to the 18th for a large number of places. All stations situated anywhere near the track of the cyclone, from which returns of rainfall have been received, are entered. A few other stations differently situated at considerable distances from the storm's path, are also included for comparison.

Table VI.—This table shows the principal kinds of clouds and weather initials, as recorded at several meteorological stations for the period from the 7th to the 18th. The numbers given after the clouds show the mean proportions of cloud-covered sky. An unclouded sky is designated by 0 and an overcast sky by 10. These data can only be trusted as approximately correct, as at most of the stations the observers are not likely to be sufficiently well trained or experienced to make this class of observations with much approach to accuracy. The observations are, however, sufficient to give a rough idea of the nature of the clouds and the general character of the weather. The abbreviations used are as follows:—

Clouds.

Cirrus ...	... C	Cirro-stratus ...	... C-S
Stratus ...	... S	Cirro-cumulus	... C-K
Cumulus ...	... K	Cumulo-stratus	... K-S
Nimbus ...	... N		

Weather Initials.

Blue sky ...	... *b*	Drizzling rain ...	... *d*
Passing clouds ...	... *c*	Lightning ...	... *l*
Dark weather ...	... *g*	Sheet-lightning	... *lr*
Hazy atmosphere	... *m*	Passing showers	... *p*
Overcast ...	... *o*	Squalls ...	... *q*
Threatening ...	... *u*	Continued rain	... *r*
Clear atmosphere	... *v*	Thunder ...	... *t*

To express a great degree the letter is doubled or repeated.

TABLE I.

*Wind Directions and Velocities.**

Stations.	October 1874.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th.	15th.	16th.	17th.	18th.
Port Blair ...	Direction	S.W.	S.E.	S.W.	S.W.	S.E.	S.E.	S.W.	S.E.	N.E.	N.E.	N.E.	N.E.
		S.W.	N.E.	S.E.	S.E.	S.E.	South	S.W.	S.E.	S.E.	East	East	S.E.
	Velocity ...	241	241	223	136	217	238	280	213	87	90	69	70
Nancowry ...	Direction	West	West	West	West	West	W.N.W.	S.W.	S.W. by W.	N.W.	N.W.	N.E.	S.E.
		West	West	West	West	W.N.W.	W.S.W.	S.W.	N.W.	N.W.	N.W.	S.W.	S E.
	Velocity ...	174	193	190	244	145	215	172	119	87	51	77	63
Akyab ...	Direction	West	S.E.	East	East	W.N.W.	S.W.	.....	East	S.E.	S.E.	North	W.N.W.
		S.E.	South	E.N.E.	N.E.	East	E.N.E.	N.E.	South	S.E.	South	East	S.E.
		East	South	South	West	N.W.	W.N.W.	East	South	South	S.W.	West	West
		West	East	South	W.N.W.	S.E.	North	E.S.E.	S.E.	S.E.	S.W.	W.N.W.	N.W.
	Velocity ...	42	30	83	30	60	55	72	81	109	67	58	68
Chittagong ...	Direction	N.W.	North	E.S.E.	N.W.	West	N.W.	North	E.N.E.	North	N.E.	Calm	Calm
		North	E.S.E.	E.S.E.	North	N.N.W.	N.N.W.	North	E.N.E.	S.E.	S.E.	South	N.N.W.
		W.S.W.	S.S.E.	S.W.	W.S.W.	W.S.W.	W.S.W.	W.S.W.	S.W.	E.S.E.	S.E.	West	East
		N.N.E.	S.E.	W.N.W.	West	N.W.	Calm	Calm	North	N.E.	E.S E.	Calm	N.W.
	Velocity ...	55	109	69	67	45	65	106	62	84	138	127	52
Silchar ...	Direction	S.E.	S.E.	N.N.E.	Calm	Calm	East	East	S.E.	N.E.	N.E.	E.N.E.	Calm
		N.W.	N.W.	S.E.	North	N.N.W.	N.N.W.	N.W.	Calm	N.N.W.	West	W.S.W.	West
	Velocity ...	35	50	68	25	39	62	58	50	79	36	77	48
Goalpara ...	Direction	W.N.W.	N.E.	Calm	South	East	E.S.E.	E.N.E.	East	East	N.E.	N.E	East
		West	S.S.W.	S.W.	Calm	N.N.E.	Calm	Calm	E.N.E.	S.W.	N.E.	N.N.W.	N.W.
	Velocity ...	19	20	33	18	11	26	53	126	105	85	301	48
Dacca ...	Direction	Calm	South	S.S.W.	South	.....	N.W.	Calm	North	Calm	East	S.S.W.	Calm
		W.N.W.	East	S.S.W.	North	N.W.	North	N.E.	W.N.W.	S.E.	S.E.	West	W.S.W.
		S.W.	S.W.	S.E.	N.N.E.	North	S.W.	N.E.	W.N.W.	N.E.	South	West	West
		Calm	South	South	Calm	Calm	Calm	North	Calm	East	South	West	West
	Velocity ...	44	50	92	71	33	56	46	56	87	206	191	58
Purneah ...	Direction	East	S.E.	South	N.W.	S.S.E.	West	S.W.	E.N.E.	E.N.E.	East	West	West
		East	S.E.	South	S.S.E.	S.S.E.	W.N.W.	W N.W.	E.N.E.	East	East	West	West

Jessore ...	Direction	S.W.	N.W.	South	S.W.	N.W.	N.N.E.	N.E.	N.N.E.	East	South	North	West
		N.E.	South	E.S.E.	N.E.	S.E.	S.E.	North	S.E.	E.S.E.	S.W.	N.W.	N.W.
	Velocity ...	27	60	71	51	40	49	66	74	111	308	78	50
Burdwan ...	Direction	Calm	S.E.	N.E.	East	Calm	North	N.E.	N.E.	East	S.W.	N.N.W.	S.W.
		Calm	South	W.S.W.	Calm	E.S.E.	N.E.	N.E.	North	E.N.E.	West	S.W.	W. by S.
	Velocity ...	39	26	42	24	35	50	52	55	75	.....	98	62
Berhampore ...	Direction	South	S.S.W.	S.S.W.	W.S.W.	Calm	N.E.	E.N.E.	N.N.E.	East	N.E.	West	S.W.
		S. E.	S.S.W.	N.E	Calm	N.E.	N.N.E.	N.E.	N.N.W.	E.N.E.	N.W.	W.S.W.	N.E.
	Velocity ...	47	25	67	98	8	52	52	57	63	.....	.....	.....
Hazareebagh ...	Direction	East	N.N.W.	N.E.	N.E.	N.E.	E.N.E.	E.S.E.	E.N.E.	N.N.W.	N.W.	N.W.	West
		N.N.W.	Calm	W.N.W.	N.N.W.	North	North	West	W.N.W.	N.W.	N.W.	W.N.W.	West
	Velocity ...	147	63	77	46	52	57	69	71	74	176	87	75
Calcutta ...	Direction	S.E.	Calm	S. by E.	Calm	S.S.E.	Calm	Calm	N.E.	N.E.	South	W.N.W.	Calm
		S.E.	S.S.E.	S.S.E.	S.S.E.	E.S.E.	N.N.E.	E.N.E.	N.E.	E N.E.	S.W.	Calm	N.W.
		S.S E.	S.S.E.	S.	E.S.E.	N.N.W.	North	N.E.	E.S.E.	E.N.E.	W.S.W.	North	W.N.W
		Calm	S. by E.	Calm	S.S.E.	Calm	Calm	N.E.	E.N.E.	E.S.E.	W.S.W.	N.N.W.	Calm
	Velocity .	82	54	62	56	47	67	103	178	198	585	111	46
Saugor Island	Direction	S.E.	S. E.	S.S.W.	N.E.	S.E.	Calm	Calm	N.E.	N.E.	S.W.	N.E.	North
		S.S.E.	N.E.	S.W.	S.E.	N.W.	N.N.W.	East	N.E.	N.E.	S.W.	S.W.	N.W.
		S.S.W.	S.S.E.	S.E.	N.E.	North	S.E.	N.E.	N.E.	S.E.	S.W.	West	S.S.W.
		S.S.E.	S.E.	S.E.	East	W.S.W.	East	N.E.	N.E.	South	N.E.	S.S.E.	S.S.W.
	Velocity ...	105	39	96	61	44	84	31	201	.....	.....	.....	.....
Cuttack ...	Direction	N.E.	West	Calm	North	Calm	Calm	West	W.N.W.	West	West	Calm	N.E.
		E.N.E.	E.N.E.	E.N.E.	N.N.E.	East	N.E.	N.N.E.	North	West	W.S.W.	N.N.E.	N.N.E.
		East	E.S.E.	S.E.	N.N.E.	S.S.W.	N.E.	Calm	N.N.E.	West	West	N.N.W.	East
		Calm	South	N.E.	Calm	Calm	Calm	Calm	North	West	Calm	W.S.W.	Calm
	Velocity ...	26	48	45	74	28	23	49	62	134	86	84	35
False Point ...	Direction	Calm	S.E.	East	Calm	Calm	Calm	N.W.	N.E.	N.N.W.	West	Calm	Calm
		South	South	N.E.	South	N.E.	Calm	North	N.E.	N.W.	West	N.E.	N.N.E.
		S.E.	East	East	S.E.	Calm	N.E.	N.E.	N.N.E.	West	West	S.E.	N.E.
		S.E.	East	East	East	Calm	Calm	N.E.	N.E.	West	West	Calm	East
	Velocity ...	Light	Light	Light	Light	Light	Light	Light	Strong	Gale	Moderate	Light	Light
Vizagapatam ...	Direction	N.E.	W.N.W.	S.W.	S.W. by W.	West	S.S.E.	W. by S.	S.W. by W.	S.W.	W. by N.	W. by S.	South
		S. by E.	N.E.	S.E. by S.	W. by S.	East	West	S.E.	South	W.S.W.	West	West	East
		S.E. by E.	East	E.N.E.	S.E.	S.S.E.	S.S.E.	S.E.	E. by N.	South	South	S.E.	S.E.
		S.E.	S.W.	West	N.E.	S.E.	S. by E.	S.E.	N.E. by N.	S.W. by W.	West	S.E.	N.E. by N.
	Velocity ...	6	20	45	27	29	12	10	22	63	56	33	10
Madras ...	Direction	W.S.W.	S.W. by W.	S.S.W.	N.W. by W.	S. by E.	S.E. by E.	South	S.E.	S.S.W.	S.S.W.	West	N. by W.
		W.N.W.	N. by W.	W.N.W.	W.N.W.	S.E. by E.	S.E.	S.E.	E.S.E.	S.E. by E.	S.E.	E. by N.	E.N.
	Velocity ...	198	162	108	60	222	258	120	156	204	108	108	108

* The numbers show the whole movement of the wind in miles during 24 hours.

TABLE II.

Barometric means, reduced for temperature and reduced to sea-level, and mean temperatures.

Stations.	Height of barometer -cistern in feet.	October 1874.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th.	15th.	16th.	17th.	18th.	Normal pressure and temperature for 10th October.
Port Blair ...	61	Pressure	29·885	29·862	29·862	29·867	29·843	29·764	29·809	29·836	29·846	29·859	29·857	29·851	29·831
		Temperature* ...	79°·3	79°·8	80°·3	79°·3	77°·3	77°·8	79°·8	80°·3	80°·3	80° 8	80°·8	80°·4	80°·4
Nancowry ...	134	Pressure	29·930	29·901	29·910	29·866	29 900	29·796	29·841	29·848	29 836	29·865	29·847	29·856	.....
		Temperature* ...	77° 6	78°·6	77° 1	77°·6	78°·6	79°·1	79°·1	79°·6	80°·1	80°·1	78°·6	78°·6	.....
Akyab	21	Pressure	29·835	29·851	29·858	29·862	29·818	29·776	29·787	29·801	29·836	29·826	29·827	29·837	29·849
		Temperature ...	80°·7	78°·9	81°·2	82°·7	84°·0	82°·8	82°·5	82°·7	83°·8	83°·4	82°·5	83°·7	81°·7
Chittagong ..	90	Pressure	29·828	29·845	29·860	29·867	29·834	29·806	29·790	29·799	29·837	29·821	29·834	29·865	29·836
		Temperature ...	80°·5	78°·5	81°·3	82°·5	82°·8	80°·4	82°·2	82°·0	80°·4	81°·0	81°·7	81° 1	81°·1
Silchar	88·91	Pressure	29·812	29·813	29·868	29·856	29·831	29·788	29·791	29·786	29·843	29·797	29·821	29·870	29·859
		Temperature ...	84°·1	81°·0	77°·6	81°·9	83°·5	83°·2	82°·4	83°·8	80°·7	81°·8	81°·5	81°·8	80°·9
Goalpara	386	Pressure	29·791	29·790	29·805	29·851	29·837	29·795	29·801	29·803	29·846	29·777	29·836	29·857	29·833
		Temperature ...	82° 7	83°·0	81°·5	82°·0	81°·8	82°·0	80°·8	80°·4	79°·4	79°·1	69°·9	75°·9	80°·2
Dacca	35	Pressure	29·796	29·807	29·829	29·849	29·813	29·779	29·780	29 782	29·808	29·748	29·809	29·854	29·834
		Temperature ...	84°·2	80°·8	83°·6	82°·6	84°·0	81°·9	83°·8	82°·8	80°·3	81°·8	79°·6	80°·8	82°·2
Jessore	20	Pressure	29·789	28·787	29·803	29·847	29·815	29·773	29·778	20·799	29·755	29·680	29·813	29 846	29·820
		Temperature ...	82°·6	83°·1	82°·9	83°·1	83°·2	84°·0	82°·5	82°·3	79°·6	79°·8	79°·6	81°·6	82°·3
Burdwan	102	Pressure	29·792	29·795	29·813	29·849	29·830	29·794	29·792	29·803	29·762	?	29·828	29·869	.....
		Temperature ...	82°·9	83°·1	82°·4	83°·9	85°·4	84°·2	83°·9	82°·1	78°·4	?	81°·9	84°·1	.. ...
Berhampore ...	64	Pressure	29·787	29·784	29·800	29·851	29·824	29·801	29·790	22·789	29·812	29·489	29·787	29·852	29·818
		Temperature ...	84°·4	84°·8	84°·8	84°·4	85°·3	85°·9	85°·3	82°·8	79°·4	74°·3	79°·4	81°·3	84°·2
Calcutta	18·11	Pressure	29·796	29·805	29·805	29·837	29·823	23·779	29·782	29·792	29·676	29·684	29·823	29·861	29·836
		Temperature ...	84°·1	83°·1	84°·0	83°·9	83°·0	84°·9	84°·3	81°·7	78°·3	79°·2	81°·6	83°·6	83°·7
Saugor Island ...	6	Pressure	29·791	29·796	29·809	29·837	29·804	29·771	29·774	29·768	29·510	29·720	29·811	29·857	29·816
		Temperature ...	83°·5	82°·4	81°·6	80°·5	82°·2	80°·4	81°·2	79°·1	79°·0	82°·7	81°·4	81°·6	82°·7
Cuttack	60	Pressure	29·786	29·785	29·804	29·844	29·825	29·784	29·782	29·755	29·690	29·760	29·821	29·861	29·873
		Temperature ...	81°·9	82°·2	81°·2	81°·5	81°·3	81°·4	81°·6	80°·5	78°·6	81°·4	81°·4	83°·0	81°·2
False Point ...	18·7	Pressure	29·798	29·801	29·813	29·846	29·834	29·803	29·785	29·750	29·634	29·771	29·838	29·879	29·843
		Temperature ...	83°·5	84°·2	84°·5	84°·7	83°·8	83°·2	82°·9	81°·4	75°·9	79° 9	81°·9	82°·4	84°·5
Vizagapatam ...	31	Pressure	29·783	29·787	29·795	29·828	29·831	29·790	29·782	29·768	29 770	29·790	29·827	29·857	29·819
		Temperature ...	83°·7	84°·5	82°·7	83°·1	83°·4	84°·0	84°·2	84° 0	84°·1	84°·0	83°·3	83°·9	83°·4
Madras	27	Pressure	29·825	29·800	29·787	29·819	29·807	29·786	29·778	29·777	29·788	29·791	29·821	29·860	29·823

* Mean of minimum and 16h. observations.

TABLE III.

Atmospheric pressures for 10 *hours and* 16 *hours, reduced for temperature, showing variations from same hour of preceding day.*

Stations.	October 1874.	Hour.	7th.		8th.		9th.		10th.		11th.		12th.		13th.		14th.		15th.		16th.		17th.		18th.	
Port Blair ...	Barometer	10	29·870	— ·003	29·855	— ·015	29·858	+ ·003	29·863	+ ·005	29·841	— ·022	29·766	— ·075	29·775	+ ·009	29·828	+ ·053	29·837	+ ·009	29·837	0	29·838	+ ·001	29·826	— ·012
		16	29·774	— ·007	29·743	— ·031	29·741	— ·002	29·745	+ ·004	29·730	— ·025	29·637	+ ·017	29·717	+ ·080	29·718	+ ·001	29·730	+ ·012	29·755	+ ·025	29·750	— ·005	29·750	0
Nancowry ...	Ditto ...	10	29·813	— ·021	29·807	— ·006	29·803	— ·004	29·754	— ·049	29·761	+ ·027	29·675	— ·106	29·747	+ ·072	29·758	+ ·011	29·749	— ·009	29·771	+ ·022	29·755	— ·016	29·753	— ·002
		16	29·770	+ ·009	29·719	— ·051	29·738	+ ·019	29·703	— ·035	29·743	+ ·040	29·641	— ·102	29·658	+ ·017	29·662	+ ·004	29·648	— ·014	29·684	+ ·036	29·663	— ·021	29·682	+ ·019
Akyab ...	Ditto ...	10	29·858	— ·017	29·871	+ ·013	29·886	+ ·015	29·916	+ ·030	29·861	— ·055	29·808	— ·053	29·826	+ ·018	29·824	— ·002	29·878	+ ·054	29·866	— ·012	29·865	— ·001	29·862	— ·003
		16	29·751	— ·010	29·770	+ ·019	29·788	+ ·013	29·772	— ·011	29·699	— ·073	29·691	— ·008	29·703	+ ·012	29·734	+ ·031	29·758	+ ·024	29·739	— ·019	29·756	+ ·017	29·771	+ ·015
Chittagong ...	Ditto ...	10	29·802	+ ·003	29·802	0	29·820	+ ·016	29·843	+ ·023	29·813	— ·030	29·766	— ·047	29·744	— ·022	29·743	— ·001	29·806	+ ·063	29·761	— ·045	29·787	+ ·026	29·829	+ ·042
		16	29·656	— ·026	29·694	+ ·038	29·698	+ ·004	29·717	+ ·019	29·657	— ·060	29·664	+ ·007	29·638	— ·026	29·661	+ ·023	29·691	+ ·030	29·667	— ·024	29·689	+ ·022	29·720	+ ·031
Silchar ...	Ditto ...	10	29·788	— ·020	29·788	0	29·833	+ ·045	29·820	— ·013	29·816	— ·004	29·764	— ·052	29·767	+ ·003	29·755	— ·012	29·778	+ ·023	29·766	— ·012	29·781	+ ·015	29·824	+ ·043
		16	29·647	— ·017	29·647	0	29·713	+ ·066	29·701	— ·012	29·657	— ·044	29·623	— ·034	29·635	+ ·002	29·627	+ ·002	29·717	+ ·090	29·637	— ·080	29·670	+ ·033	29·725	+ ·055
Goalpara ...	Ditto ...	10	29·471	— ·015	29·467	— ·004	29·471	+ ·004	29·540	+ ·069	29·526	— ·014	29·469	— ·057	29·477	+ ·008	29·475	— ·002	29·494	+ ·019	29·479	— ·015	29·466	— ·013	29·513	+ ·047
		16	29·324	— ·031	29·325	+ ·001	29·348	+ ·023	29·373	+ ·025	29·358	— ·015	29·350	— ·028	29·334	+ ·004	29·338	+ ·004	29·405	+ ·067	29·282	— ·123	29·397	+ ·115	29·404	+ ·007
Dacca ...	Ditto ...	10	29·827	— ·014	29·831	+ ·004	29·838	+ ·007	29·891	+ ·053	29·858	— ·033	29·811	— ·047	29·804	— ·007	29·795	— ·009	29·859	+ ·064	29·769	— ·090	29·825	+ ·056	29·877	+ ·052
		16	29·689	— ·025	29·710	+ ·021	29·709	— ·001	29·751	+ ·042	29·703	— ·048	29·667	— ·036	29·679	+ ·012	29·696	+ ·017	29·742	+ ·046	29·642	— ·100	29·737	+ ·095	29·774	+ ·037
Jessore ...	Ditto ...	10	29·835	— ·002	29·821	— ·014	29·843	+ ·022	29·892	+ ·049	29·873	— ·019	29·818	— ·055	29·814	— ·004	29·807	— ·007	29·789	+ ·018	29·683	— ·106	29·832	+ ·149	29·875	+ ·043
		16	29·706	— ·022	29·712	+ ·009	29·723	+ ·011	29·760	+ ·037	29·716	— ·044	29·688	— ·028	29·700	+ ·012	29·751	+ ·051	29·630	— ·071	29·636	— ·044	29·753	+ ·117	29·777	+ ·024
Burdwan ...	Ditto ...	10	29·756	— ·004	29·758	0	29·775	+ ·017	29·820	+ ·045	29·804	— ·016	29·760	— ·044	29·756	— ·004	29·751	— ·005	29·733	— ·018	P	P	29·765	P	99·826	+ ·061
		16	29·625	— ·025	29·632	+ ·007	29·650	+ ·018	29·680	+ ·030	29·658	— ·022	29·630	— ·028	29·630	0	29·654	+ ·024	29·591	— ·063	29·568	— ·023	29·690	+ ·122	29·713	+ ·023
Berhampore ...	Ditto ...	10	29·785	— ·015	29·777	— ·008	29·779	+ ·002	29·843	+ ·064	29·837	— ·006	29·798	— ·039	29·782	— ·016	29·780	— ·002	29·793	+ ·012	29·451	— ·341	29·783	+ ·332	29·839	+ ·056
		16	29·655	— ·022	29·659	+ ·004	29·688	+ ·029	29·726	+ ·038	29·677	— ·049	29·671	— ·006	29·665	— ·006	29·683	+ ·018	29·699	+ ·016	29·393	— ·306	29·658	+ ·265	29·731	+ ·073
Hazareebagh ...	Ditto ...	10	27·831	+ ·009	27·839	+ ·008	27·851	+ ·012	27·906	+ ·055	27·898	— ·008	27·863	— ·035	27·853	— ·010	27·857	+ ·004	27·849	— ·008	27·810	— ·039	27·856	+ ·046	27·917	+ ·061
		16	27·740	+ ·006	27·752	+ ·012	27·757	+ ·005	27·794	+ ·037	27·782	— ·012	27·748	— ·034	27·756	+ ·008	27·764	+ ·008	27·739	— ·025	27·728	— ·011	27·784	+ ·056	27·833	+ ·049
Calcutta ...	Ditto ...	10	29·835	0	29·839	+ ·004	29·856	+ ·017	29·883	+ ·027	29·883	0	29·823	— ·060	29·831	+ ·008	29·817	— ·014	29·772	— ·045	29·704	— ·068	29·852	+ ·148	29·909	+ ·057
		16	29·700	— ·053	29·724	+ ·024	29·711	— ·013	29·764	+ ·053	29·738	— ·026	29·701	— ·037	29·705	+ ·004	29·749	+ ·044	29·615	— ·134	29·671	+ ·056	29·774	+ ·103	29·785	+ ·011
Saugor Island ...	Ditto ...	10	29·852	— ·006	29·846	+ ·014	29·860	+ ·014	29·895	+ ·035	29·890	— ·005	29·825	— ·065	29·852	+ ·027	29·822	— ·010	29·621	— ·201	29·756	+ ·135	29·852	+ ·096	29·906	+ ·054
		16	29·726	— ·016	29·737	+ ·009	29·746	+ ·009	29·787	+ ·041	29·702	— ·085	29·711	+ ·009	29·721	+ ·010	29·726	+ ·005	29·219	— ·507	29·692	+ ·473	29·768	+ ·076	29·815	+ ·047
Cuttack ...	Ditto ...	10	29·748	+ ·029	29·734	— ·014	29·760	+ ·026	29·807	+ ·047	29·814	+ ·007	29·753	— ·061	29·744	— ·009	29·728	— ·016	29·661	— ·067	29·728	+ ·067	29·784	+ ·056	29·825	+ ·041
		16	29·642	+ ·005	29·645	+ ·003	29·664	+ ·019	29·720	+ ·056	29·684	— ·036	29·656	— ·028	29·648	— ·008	29·628	— ·020	29·546	— ·082	29·624	+ ·078	29·685	+ ·061	29·727	+ ·042
False Point ...	Ditto ...	10	29·819	— ·014	29·827	+ ·008	29·845	+ ·018	29·885	+ ·040	29·886	+ ·001	29·831	— ·055	29·821	— ·010	29·771	— ·050	29·594	— ·177	29·804	+ ·210	29·861	+ ·057	29·910	+ ·049
		16	29·725	— ·009	29·727	+ ·002	29·743	+ ·016	29·783	+ ·040	29·779	— ·004	29·725	— ·054	29·710	— ·015	29·696	— ·014	29·577	— ·119	29·702	+ ·125	29·779	+ ·077	29·819	+ ·040
Vizagapatam ...	Ditto ...	10	29·816	+ ·022	29·786	— ·030	29·817	+ ·031	29·858	+ ·041	29·873	+ ·015	29·803	— ·070	29·817	+ ·014	29·801	— ·016	29·796	— ·005	29·816	+ ·020	29·856	+ ·040	29·864	+ ·008
		16	29·702	— ·018	29·705	+ ·003	29·712	+ ·007	29·753	+ ·041	29·748	— ·005	29·681	— ·067	29·699	+ ·018	29·675	— ·024	29·685	+ ·010	29·707	+ ·022	29·757	+ ·050	29·796	+ ·038
Madras ...	Ditto ...	10	29·870	+ ·007	29·829	— ·041	29·818	— ·011	29·855	+ ·037	29·849	— ·006	29·834	— ·015	29·811	— ·023	29·814	+ ·003	29·839	+ ·015	29·823	— ·001	29·833	+ ·005	29·872	+ ·039
		16	29·734	— ·041	29·714	— ·010	29·700	— ·014	29·728	+ ·023	29·708	— ·020	29·683	— ·025	29·688	+ ·005	29·684	— ·004	28·691	+ ·007	29·699	+ ·008	29·752	+ ·053	29·792	+ ·040

TABLE IV.

Humidity.

October 1874.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th.	15th.	16th.	17th.	18th.	Normal humidity for October.
Port Blair*	80	74	76	82	92	87	82	76	74	74	74	72	80
Nancowry*	70	75	80	78	73	71	71	64	61	68	67	71	73†
Akyab	91	91	86	83	86	85	?	82	83	85	84	84	86
Chittagong	89	89	86	82	85	88	79	83	85	87	85	79	83
Silchar*	79	77	79	76	80	72	74	67	82	78	80	79	86
Goalpara*	68	76	87	76	71	75	77	63	77	85	97	82	81
Dacca	84	93	83	85	81	85	82	79	92	86	82	81	81
Purneah*	79	76	85	76	62	46	72	55	61	73	86	66	.....
Jessore*	68	77	72	74	71	66	60	69	93	85	72	69	82
Burdwan*	74	72	81	76	79	75	63	69	94	?	80	83	.....
Berhampore*	62	76	84	81	78	71	60	61	90	95	78	78	76
Hazareebagh*	85	79	69	59	59	64	73	61	77	85	65	43	64
Calcutta	81	86	84	85	85	83	80	78	95	88	84	82	79
Saugor Island...	82	81	83	89	88	89	85	87	92	85	80	85	83
Cuttack	85	84	87	89	84	82	85	81	80	79	84	79	78
False Point	84	81	80	83	83	86	85	83	92	84	80	77	79
Vizagapatam	82	78	81	79	79	75	76	76	78	78	79	77	73
Madras*	54	57	71	73	66	68	68	68	67	73	75	77	69

* Arithmetic means of 10h. and 16h. observations.
† Mean for October 1873.

TABLE V.

Rainfall.

	October 1874.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th.	15th.	16th.	17th.	18th.
	Port Blair	0·07	0·02	0·12	0·06	0·08	1·12	0·25	0·29	...	1·07	...	...
	Nancowry	2·06	0·24	0·08	...	...	0·09	...	0·09	...	...	0·07	2·08
	Madras	...	0·11	...	...	1·04	...	0·03	...	...	2·16	0·76	0·24
	Akyab	...	1·34	...	...	...	...	...	...	0·48	0·02	...	...
	Vizagapatam	...	0·10	0·70	1·80	0·20	...	...	...	...	0·40	...	...
	BENGAL.												
	Western Districts.												
	Burdwan	...	...	0·04	0·02	0·48	0·18	...	...	0·36	7·43	...	...
	Cutwa	...	0·32	...	0·12	...	...	...	...	0·30	4·30	...	...
	Culna	...	...	...	1·34	...	...	...	...	0·26	2·43	...	...
Burdwan	Bood-Bood	...	...	...	...	0·35	0·23	...	...	0·26	3·40	...	...
	Raneegunge	...	...	...	...	...	0·12	...	...	0·04	1·31	...	...
	Jehanabad	...	...	1·10	...	...	...	...	...	0·94	3·95	...	...
Bankoora	Bankoora	0·14	...	0·16	...	...	...	...	...	0·13	1·62	...	...
Beerbhoom	Sooree	0·17	...	...	...	...	...	...	...	0·15	4·69	...	...
	Midnapore	...	...	...	...	...	0·11	...	0·24	10·27	...	...	...
	Tumlook	...	...	...	...	1·12	...	...	...	0·87	4·50	...	...
Midnapore	Gurbetta	0·02	...	0·24	0·01	...	...	...	...	...	0·12	...	...
	Contai	...	...	...	0·38	0·57	0·18	...	0·47	3·68	5·47	...	...
	Hooghly	...	0·45	0·02	...	...	0·07	...	...	4·12	...	0·07	0·14
Hooghly	Serampore	...	...	...	...	...	...	...	...	1·78	4·60	...	...
Howrah	Howrah	0·10	0·70	...	...	0·69	0·01	0·01	...	1·18	4·35	...	...
	Saugor Island	...	...	0·09	0·19	0·27	1·18	...	0·06	3·90	1·44	...	...
	Sealdah	...	1·33	0·10	...	0·70	...	0·16	...	1·17	3·85	...	...
	Calcutta	1·03	0·17	0·02	...	0·06	0·19	...	...	1·27	4·56	...	..
	Alipore	...	0·38	...	0·05	...	0 10	...	...	1·10	4·38	...	...
	Busseerhat	...	...	...	...	0·84	...	...	0·25	0·86	1·10	...	...
24-Pergunnahs ...	Baraset	...	...	0·07	...	0·13	...	...	...	2·12	3·00	...	...
	Diamond Harbour	0·39	0·02	0·29	...	...	...	...	...	3·32	...	...	...
	Baripore	0·06	...	...	...	...	...	...	...	1·53	4·95	...	...
	Satkhira	...	...	...	...	...	...	...	0·27	0·93	0·13	...	...
	Barrackpore	...	...	...	...	...	...	...	...	1·70	4·60	...	...
	Dum-Dum	...	...	...	...	...	...	...	...	0·46	4·60	...	..
	Kishnaghur	...	...	...	...	...	...	...	...	0·14	2·10	...	...
	Bongong	0·08	0·12	...	...	...	...	...	...	0·63	1·60	...	...
	Meharpore	...	...	0·17	...	...	...	...	...	0·16	0·17	...	...
Nuddea	Chooadangah	...	...	...	2·00	...	...	...	...	0·55	1·10	...	...
	Kooshtea	...	...	...	0·17	...	...	...	...	0·79	1·15	...	...
	Ranaghat	...	0·33	...	...	...	...	...	...	1·62	0·50	...	...
	Jessore	...	...	...	...	...	...	...	...	0·96	0·78	...	...
	Narail	...	...	...	...	...	...	...	0·03	1·28	0·54	...	...
	Khoolneah	...	...	...	...	...	...	0·70	0·60	1·00	1·10	...	...
Jessore...	Jenadah	...	...	...	...	...	...	...	...	1·80	1·50	...	...
	Bagirhat	...	...	...	...	...	...	...	1·26	1·06	0·02	...	...
	Magoorah	...	...	...	...	...	...	...	...	0·50	1·26	...	...
	Berhampore	...	...	...	...	...	...	...	...	0·49	5·93	0·03	...
	Rampore Haut	0·14	...	0·78	...	...	0·18	...	...	...	5·92	...	...
Moorshedabad ...	City Moorshedabad	...	0·10	0·85	...	...	...	...	...	3·02	2·80	...	...
	Jungipore	...	...	0·94	...	...	...	...	...	1·33	8·00	...	...
	Azimgunge	...	...	2·14	0·07	...	...	...	...	0·29	4·93	...	...
	Lalgolla	...	...	...	0·03	...	...	...	...	1·10	16·30	0·40	...
Dinagepore	Dinagepore	...	...	...	...	...	...	...	...	...	0·28	2·80	...
Maldah	Maldah	...	...	0·43	...	...	...	...	...	0·12	2·92	0·05	...
	Chanchal	...	...	...	...	...	...	...	...	...	1·04	0 03	...
Rajshahye	Beauleah	...	...	0·62	0·36	...	...	...	...	0·32	3·80	...	...
	Nattore	...	...	0·47	0·10	...	...	...	...	1·10	3·13	...	...

TABLE V.—(*Continued.*)

	October 1873.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th.	15th.	16th.	17th.	18th.
Rungpore	Rungpore	...	...	...	...	...	...	...	...	...	1·89	6·97	...
	Bhowanigunge	...	...	...	...	...	...	...	...	0·51	2·85	2·15	...
	Titalya	...	...	...	...	...	...	...	...	...	...	0·22	...
Bogra	Bogra	...	...	1·18	...	...	...	...	...	1·34	3·10	...	...
Pubna	Pubna	...	...	0·29	...	...	...	...	...	0·12	1·42	...	...
	Serajgunge	...	...	2·05	...	...	...	...	...	0·16	0·76	0·06	...
Darjeeling	Darjeeling	0·75	0·04	...	...	0·04	0·48	...	...	...	0·04	0·03	...
Julpigoree	Julpigoree	...	...	...	0·07	...	...	...	...	0·03	0·60	...	...
	Bodah	...	...	...	1·43	...	...	...	...	...	...	1·10	...
	Buxa...	...	...	0·05	0·07	0·66	0·05	...	...	...	0·88	1·22	...
Cooch Behar Tributary State	Cooch Behar	...	0·08	0·05	0·27	...	...	...	...	...	0·56	3·96	...
	Eastern Districts.												
Dacca	Dacca	...	0·57	...	...	...	1·40	...	...	0·38	0·04	0·02	...
Furreedpore	Furreedpore...	...	...	...	...	...	...	...	...	0·35	0·75	...	...
	Goalundo	...	...	...	...	...	...	...	...	...	0·29	0·15	...
	Madaripore	...	1·50	...	...	...	...	...	2·00	2·00	0·52	0·50	...
Backergunge	Burrisal	...	0·09	...	...	...	0·36	...	0·11	1·40	0·16	...	...
Mymensingh	Mymensingh	...	0·25	...	...	...	...	...	0·56	0·88	0·01	...	...
Chittagong	Chittagong	0·13	1·13	0·09	...	0·08	...	...	...	...	...	...	...
	Cox's Bazar	...	0·80	...	0·10	...	...	...	...	0·10	0·30	...	...
Noakholly	Noakholly	1·70	0·23	1·68	0·20	...	...	...	0·02	0·48	0·40	0·03	...
Tipperah	Comillah	...	2·67	...	...	...	0·27	...	...	0·10	...	...	...
Chittagong Hill Tracts	Rangamatee Hill	3·16	1·65	0·72	0·04	...	...	...	0·02	0·13	0·06	0·03	...
Hill Tipperah... ...	Hill Tipperah	0·30	1·49	0·24	...	...	0·18	...	0·50	...	0·05	0·03	0·02
	Behar.												
Patna	Patna	3·60	...	...	...	...	...	...	...	...	...	...	...
Gya	Gya	0·25	0·09	...	...	...	...	...	...	...	...	...	...
Shahabad	Arrah	0·45	0·34	...	...	...	...	...	...	...	...	...	...
Tirhoot	Mozufferpore	0·50	...	...	...	...	...	...	...	...	...	...	...
Sarun	Chupra	0·64	...	...	...	...	...	...	...	...	...	...	...
Chumparun	Motiharee	0·25	...	...	...	...	...	...	...	...	...	...	...
Monghyr	Monghyr	...	0·15	...	...	...	...	...	...	...	...	...	...
Bhagulpore	Bhagulpore	...	0·02	0·07	...	...	...	...	...	0·11	...	...	...
Purneah	Purneah	...	0·14	...	...	...	...	...	...	...	0·03	...	...
Sonthal Pergunnahs	Deoghur	...	...	0·15	...	...	...	...	...	...	...	...	...
	Orissa.												
Cuttack	Cuttack	...	0·80	1·10	0·05	0·85	1·05	0·04	...	0·05	...	...	...
	Jajeepore	...	0·80	0·40	0·10	...	...	0·10	...	0·45	...	...	...
	Kendraparah	...	...	...	1·10	...	...	...	0·30	1·20	...	...	...
	Jagatsingpore	...	...	0·50	0·30	0·70	...	...	...	...	...	...	...
	False Point	...	...	...	0·10	...	...	2·10	0·90	6·30	...	...	...
Pooree	Pooree	...	0·03	0·04	0·05	0·15	0·09	0·32	...	...	...	...	...
	Khoordah	...	...	0·04	0·16	0·05	...	...	...	0·09	...	0·11	0·60
Balasore	Balasore	0·02	0·37	0·37	0·34	...	0·08	...	...	1·28	0·30	...	...
	Bhadrack	...	...	0·11	...	...	...	...	...	0·79	...	0·22	...
	Jellasore	...	...	0·71	0·77	...	...	...	0·71	5·32	...	...	...
	Sorah	...	...	...	1·10	...	...	...	...	1·00	...	...	...
	Chandbally...	0·17	1·00	0·10	1·00	...	0·97	...	0·53	1·63	...	...	...
Cuttack Tributary Mehals...	Sambalpore	0·32	...	...	0·41	...	...	0·46	0·47	...	...	...	...
	Chota Nagpore.												
Hazareebagh	Hazareebagh	0·60	0·44	0·04	...	...	...	0·46	...	0·10	0·06	...	...
Lohardugga	Ranchee	1·52	...	0·13	...	...	...	...	...	0·14	0·35	...	...
Singhbhoom	Chybassa	0·06	...	...	0·02	...	...	...	...	0·59	0·13	...	...
Manbhoom	Purulia	...	...	...	...	...	...	...	...	0·78	0·06	...	...
	Assam and Adjacent Hills.												
Sylhet	Sylhet	0·15	...	3·25	0·15	...	...	...	...	...	0·15	...	...
Cachar	Silchar	0·10	0·01	3·37	...	0·25	...	...	...	0·48	0·08	0·41	...
Goalpara	Goalpara	...	...	0·21	...	...	...	...	...	...	...	4·57	0·05
	Dhoobree	...	...	...	...	...	...	...	...	...	2·80	2·50	...
Kamroop	Gowhatty	...	...	0·58	0·02	...	...	...	...	0·01	0·01	0·17	0·40
	Burpettah	...	...	...	...	...	...	...	...	...	...	3·60	0·15
Durrung	Teapore	...	...	...	0·62	0·11	...	...	...	...	0·01	4·05	0·11
	Mungledye	...	...	...	0·01	0·50	...	...	...	...	...	1·00	0·57
Nowgong	Nowgong	...	...	0·50	...	...	...	...	...	...	0·07	0·39	...
Seebsaugor	Seebsaugor	...	0·83	0·88	...	...	1·40	0·17	...	...	0·01	0·03	1·46
Luckimpore	Debrooghur	...	...	0·25	...	...	2·21	...	...	...	...	...	0·37
Khasi and Jynteah Hills	Shillong	...	...	0·55	...	...	0·12	...	...	...	0·12	0·27	...
	Cherrapoonjee	...	...	0·36	0·13	...	0·25	...	...	0·06	...	2·33	...
Garo Hills	Tura	...	...	2·53	0·01	0·01	...	...	...	0·48	0·61	1·30	0·01

TABLE VI.

Clouds and Weather Initials.

October 1874.		9th.	10th.	11th.	12th.	13th.	14th.	15th.	16th.	17th.
Port Blair	Clouds ...	Light and dark clouds, 1·5.	Light and dark clouds, 1·5.	Light and dark clouds, 6·5.	Light and dark clouds, 3·5.	Light and dark clouds, 5.	Light and dark clouds, 1.	Light clouds, 2.	Light clouds, 3·5.	Light clouds, 2·5.
Nancowry	Clouds ...	N. 9.	N. 8.	C, S. 6.	K, S. 3.	K, S. 4·5.	N. 8·5.	K, S, N. 8.	K, S, N. 9.	N. 8·5.
	Weather ...	*r, t.*	*o.*	*o, c.*	*c, b.*	*c, b.*	*p, v.*	*c, p.*	*o, p.*	*p, o.*
Akyab	Clouds ...	C, CK, N. 3.	CK, N. 0·5.	CK, N, C. 7.	CK, N, C. 6.	CK, N. 7.	CK, N. 6.	CK, N. 5·5.	N, CK. 6.	C, CK, N. 4.
	Weather ...	*v, b.*	*v, b.*	*v, b, q, t, lr.*	*v, b, lr.*	*b, g, v.*	*v, b.*	*v, b, g, r.*	*g, b, v, lr.*	*v, b, g.*
Chittagong	Clouds ...	KS, CK, K. 6.	CK, K, KS. 3.	K, CK, C, KS. 3·5.	K, C, KS. 5.	K, C. 1.	CK, K, KS. 3·5.	K, KS, CK. 3.	K, KS. 3.	K, C. 3.
	Weather ...	*u, v.*	*v, t.*	*v, t.*	*v, u, o, t, l.*	*v.*	*v.*	*v, u.*	*v.*	*v. m.*
Cachar	Clouds ...	N, K, KS. 9.	K, KS, C, CS. 7.	K, C, KS. 4·5.	K, S, C. 5.	K. 2.	K, S. 4.	C, K, S. 10.	K, C, KS. 8.	KS, C, K, N. 8·5.
	Weather ...	*r, o.*	.....	.....	.....	.....	.....	*r.*	.....	.....
Goalpara	Clouds ...	C, KS. 5·5.	C, CS. 2.	None. 0.	Souds, C. 1.	C. 4·5.	None. 0.	C, CK, Souds. 8.	Souds, 10.	N. 10.
	Weather ...	*c, t, l.*	*c.*	*v, b.*	*c.*	*c.*	*v, b.*	*c, g.*	*d, t, l.*	*p, r, d, t, l.*
Dacca	Clouds ...	K, CS, C. 4.	K, C, CS. 5·5.	K, C. 2.	CK, K, KS, CS. 3.	CK, K, C. 0·5.	K, KS, C. 6.	K, KS. 10.	K, KS. 10.	CK, CS, K, C. 4.
	Weather ...	*c, v, b, m.*	*b, c, m, o, lr.*	*b, v, c, m.*	*b, c, o, r.*	*b, c, m.*	*b, c, m.*	*o, g, d, q.*	*o, m, q, g.*	*o, b, p, m.*
Purneah	Clouds ...	CK. 8.	CK, N. 6·5.	CK. 2·5.	CK. 2.	CK, 1·5.	CK. 2.	CK. 9.	CK. 10.	CK. 3·5.
	Weather ...	*c.*	*c, b.*	*b.*	*b.*	*b.*	*b.*	*c.*	*c.*	*b.*
Jessore	Clouds ...	K, KS, C, S. 4.	K, KS, C, S. 4·5	K, KS, C, S. 4.	K, KS, CS, S. 3·5.	C, CK, KS, CS. 1.	C, CS, S, KS. 6.	K, KS, S, N. 10.	K, C, KS, S. 9·5.	C, K, KS. 1·5.
	Weather ...	*v, c, b, l, t.*	*v. c, b, lr.*	*c, v, b, lr.*	*b, v.*	*b, v.*	*b, c.*	*o, d, t.*	*c, p, c, d.*	*v, b.*
Burdwan	Clouds ...	K, N, KS. 7.	CK, N. 5.	CK, N. 4.	CK, N. 6.	KS, C. 1.	C, N, S. 7.	N, S. 10.	N, S. 10.	C, KS, K. 1.
	Weather ...	*c, p.*	*d, b.*	*p, c.*	*b, c.*	*b.*	*b, o.*	*o, d, p.*	Cyclone, *o, qqq, rrr.*	*b.*
Berhampore	Clouds ...	C, K. 7·5.	C, K. 9·5.	K. 6.	K, C. 5.	K. 0·5.	CK. 7.	C, K, S. 10.	N. 10.	K. 3·5.
	Weather ...	*c.*	*c, c.*	*c.*	*b, c.*	*b.*	*c.*	*o, d.*	Cyclone, *o, qq, rr.*	*b.*
Hazareebagh	Clouds ...	C, K. 4.	C, CK. 2·5.	C, K. 2.	C, K, N. 5.	C, K, N. 6.	C, K. 5·5.	C, K, N. 9·5.	C, N, K, S.	CS, C, K. 4·5.
	Weather ...	*lr.*	*b, lr.*	*b, lr.*	*lr.*	*t, l, lr.*	*lr.*	*lr.*	*d, lr.*	*b.*
Calcutta	Clouds ...	K.	K, C.	K.	K, CS.	K.	C, K, S.	N, S.	S.	K.
	Weather ...	*b.*	*b.*	*b.*	*b.*	*b.*	*b, c.*	Souds, *o, p, q, r.*	*o, b.*	*b.*
Sangor Island... ...	Clouds ...	S, N, CK, KS. 4·5.	N, K, C, KS. 5.	N, C. 5.	C, S, K, N, KS. 3.	S, C, K, N, KS. 5.	S, N. 7.	N. 10.	N. C, CK. 7.	C, K, N, KS. 3.
	Weather ...	*b, p, v, lr.*	*b, p, v, lr.*	*b, v, u, t, lr. l.*	*b, v, t, lr.*	*b, v, u, t, lr.*	*b, d, o, u, t.*	Cyclone, Souds, *o, u, qq, rr.*	Souds, *d, o, u, r, b.*	*b, v.*
Cuttack...	Clouds ...	CK, C, K, N. 3.	K, N, C. 3·5.	CK, C, K, N. 3.	CK, K, N, C. 4.	C, CK, K, N. 5.	C. N. 6.	C, N. 7·5.	K, C, CK. 2.	N, CK, C. 6.
	Weather ...	*b, c, p, t.*	*b, p, d, t.*	*b, c, p, t.*	*b, u, c, t, lr.*	*b, c, d, t.*	*b, c.*	*c, q.*	*b.*	*t, c.*
False Point	Clouds ...	Cloudy, C, K.	Cloudy, C, K.	Cloudy, K.	Cloudy, K.	Cloudy, K.	Cloudy, K, N.	N. Cloudy.	Clear, C.	Cloudy, K.
	Weather ...	Fair.	Fair.	Fair, *t, l.*	Fair, *t.*	Fair, *t, l.*	*u*, Gale.	*rr*, heavy gale.	Fine.	Fine.
Vizagapatam	Clouds ...	C, S, N. 8·7.	N, K. 5.	N, K, C. 5.	C, K. 2.	K, 4·5.	K, C, S. 4.	K, C, S. 5.	N, C, K, S. 5.	K, C. 4.
	Weather ...	*b, o, t, l.*	*o, b, t, l.*	*o, b, l.*	*b, l.*	*b, t, l.*	*b, l.*	*b, v, l.*	*o, b, t, l.*	*b, t, l.*
Madras	Weather ...	*o.*	Cloudy.	*c*, Cloudy.	*c.*	*c.*	*c.*	*c.*	*c*, Cloudy.	Cloudy.

Meteorological Discussion.

Winds.—In Lower Bengal the winds in the early part of October were, as is usual at the time of the change of the monsoon, extremely light and variable, and calms were of frequent occurrence. At many places the northerly monsoon current had been slightly felt at intervals. At Calcutta and Saugor Island the wind directions had been northerly during the first three days of the month, from which time up to the 11th they were mostly south-easterly. At Cuttack very light north-easterly airs and calms prevailed from the commencement of the month. At False Point the winds were more variable than at Cuttack, but chiefly from S.E. and E. up to the 11th. On the Arakan coast at Akyab and Chittagong the winds were also very light and variable. At both of these places, and also at False Point, when no steady monsoon is blowing, the winds partake of the nature of land and sea breezes.

The state of affairs in the south of the Bay was very different. At Nancowry a strong, squally westerly wind was prevalent from the commencement of the month, and the weather was rainy and the sky overcast. The diurnal velocity of the wind, which was registered at 328 miles in the 24 hours on the 2nd, gradually decreased to 190 miles on the 9th, and from the 10th there was a considerable improvement in the weather. At Port Blair,* also, there was a strong monsoon, principally from S.E. and S.W., and the same kind of winds and weather seem to have extended across the Bay to Madras. As will be seen further on, the ships *Ireshope* and *Patrie*, coming up the south of the Bay in the early part of the month, and on the 7th of October about 200 and 140 miles, respectively, due west of Port Blair, met with very squally rainy weather, and strong W.S.W. and S.W. winds, between latitude 6° and 13° N.

From the 12th October until the passage of the cyclone the winds to the north of the Bay became northerly, chiefly N.E., but still continued very light, with calms more frequent than before. The winds at the Sandheads, about 40 miles S.S.E. from Saugor Island, were very similar in character to those observed at the latter place. The north-easterly winds seem, however, to have set in somewhat earlier, but did not blow with any force until the afternoon of the 14th (see log of *Coleroon*). At Saugor Island it was calm at sunset on the evening of the 14th, and the wind did not get strong before the morning of the 15th (see log of *Mistley Hall*), when the centre of the cyclone was not 110 miles distant.

Atmospheric pressures.—From the 1st of the month up to the 10th the barometer rose gradually at all the Bengal stations. About the latter date there was a change; the barometer commenced to fall generally, although for the most part very slowly, until the 12th. At Akyab there was a slight fall until the 12th, after which the pressure increased. At Chittagong the fall continued from the 10th to the 13th, or a day later than at Akyab, after which the barometer rose steadily up to the 15th. At Calcutta the barometer fell slightly on the 11th and 12th, but rose again slightly on the 13th and 14th. At Saugor Island the barometer fell on the 11th and the forenoon of the 12th, but rose again slightly on the afternoon of the latter day, after which it was unsteady up to the evening of the 14th, when there was a very slight rise. Further north there had been a small decrease of pressure on the 11th and 12th, from which time it generally increased until shortly before the passage of the cyclone. At Cuttack and False Point the pressure continued to decrease slowly from the 10th until after the passage of the storm.

In the south of the Bay the behaviour of the barometer was somewhat different. At Nancowry there was no remarkable change of pressure up to the 6th, but from this date the barometer fell irregularly up to the 10th. There was a slight rise on the 11th, and then a very considerable fall on the 12th, after which the pressure increased. At Port Blair the barometer was irregular from

* Wind directions are only entered to eight points of the compass in the Port Blair registers. Weather initials and the different kinds of clouds are not recorded.

the 1st to the 6th, showing, on the whole, a slight rise. It fell very slightly from the 6th, but rose a little on the 9th, from which day there was a fall up to the evening of the 12th, after which there was a steady rise. At Madras there was a slight decrease of pressure from the 6th to the 10th, when the barometer rose. After this date there was a slight fall up to the 14th. During all these days there was nothing unusal in the behaviour of the barometer round the north of the Bay, except, perhaps, its irregularity. The variations of pressure which have been noticed above were all small, with the exception of those in the south-east of the Bay. On the 10th the pressure was almost everywhere at the land stations a little above the average for the season, and, as is usual at the change of the monsoon, was nearly equable over Bengal and round the Bay. The fall from this date to the 14th was everywhere very inconsiderable. It is not forgotten that the normal state of the barometer at this season of the year is a rising one—the rise being more rapid in Bengal and round the north of the Bay than in the south—so that a fall of the barometer at this time of year means much more than an equal fall at the commencement of the south-west monsoon, when the pressure is normally decreasing to the solstitial minimum. However, the changes of pressure from the 10th to the 14th were, in this case, small, even compared with the ordinary barometric oscillations which occur in the most settled weather. It will appear further on (see log of the *Coleroon*) that even at the Sandheads, about 40 miles S.S.E. of Saugor Island, the barometer was not appreciably affected by the approach of the cyclone before midnight of the 14th, when the centre of the storm was probably not more than about 90 miles distant.

The most remarkable feature in the atmospheric pressure round the Bay during the early days of October relates to its distribution, and remains to be noticed. On the 1st of October the mean pressure, reduced to sea-level at Nancowry, was 29·913 inches; and on the 6th 29·937. At Saugor Island the pressures on the same dates were, respectively, 29·679 and 29·790, and at Port Blair 29·830 and 29·890. Thus, on the 1st, the pressure at Nancowry was 0·234 inches higher than at Saugor Island and 0·083 higher than at Port Blair. On the 6th these gradients were reduced to 0·147 and 0·047, respectively; and on the 7th to 0·139 and 0·045. On the 9th they had further changed to 0·101 and 0·048. These gradients were all unusually large for a tropical sea at the time of year. The mean pressures, reduced to sea-level, for the month of October 1873, at Nancowry and Port Blair, are given in the Bengal Meteorological Report for the same year as 29·820 and 29·840; so that, if it is lawful to draw conclusions from the observations of a single year, the pressure at Nancowry was not only excessively high on the 6th, but also the normal atmospheric gradient between that place and Port Blair was reversed in direction, notwithstanding that the pressure at the latter place was also considerably in excess of the average. At Saugor Island the pressure on the 6th was about the average for the time of year.

Temperature.—There was, on the whole, nothing remarkable about the variations of temperature for some days before the cyclone. Following a rainy period in the latter days of September and the first few days of October, there had been very generally a slight rise of temperature from about the 4th or 5th of the month up to the 11th or 12th, as the weather cleared up. There was a very general change, however, from about the 12th; and, with the advent of northly winds on that date, the temperature decreased at most of the Bengal stations until after the passage of the storm. The mean temperatures on the 12th were generally a little above the average for the time of year; but there is nothing in the variations of temperature, as recorded, which strikes me as deserving of any special notice, or likely to throw much light on the origin and cause of the cyclone.

Humidity.—The variations of this element before the storm were not of a character to deserve any very special notice. At Port Blair the humidity from the 10th to the 13th was above the average for the month; and such, also, seems to have been the case at Nancowry from the 8th to the 10th. In Bengal, at

stations near the coast-line, the humidity was high for the time of year, and continued so throughout the month. At inland stations there was generally a decrease from about the 9th to the 14th as the weather cleared up, and as northly winds became prevalent. On the latter date the humidity was below the average of the month at most of the inland stations.

General weather, clouds, and rainfall.—The rainy season of 1874 round the Bay and in Lower Bengal was extremely abnormal in its features. In the early months of the monsoon—June, July, and August—the rainfall had been exceedingly scanty in Bengal, although unusually heavy in the Central Provinces, the North-Western Provinces, and Behar. The stormy weather, which generally ushers in the rainy season, was unusually prolonged; and gales were of frequent occurrence in the north of the Bay, even as late as the first week in August. With the slackening of the monsoon current and the advent of variable winds, a change took place in the distribution of rainfall, which became unusually heavy in September and the early days of October all over Bengal. From the 6th to the 9th of October, the date varying for different places, the weather commenced to clear up. There were occasional showers at some places, but the rainfall was not, on the whole, heavy or general. The period, from about the 10th to the 14th, was mostly rainless all over Bengal. There were, however, occasional showers at a few places, principally lying near the coast-line. The general character of the weather was such as is usual at the time of year—light, variable winds or calms, with a clear, transparent atmosphere, and a blue sky, partially covered with cirrus and cumulus. Up to the 12th, following the rainy period in the early part of the month, the temperature had slightly increased at most stations in Bengal, and the weather was very close and warm for the season.

From the 1st of the month to the 10th the weather was bad in the south-east of the Bay at Nancowry. The sky was almost always overcast, and nimbus was the prevailing cloud. There was heavy rain on the 6th and 7th; but from the 10th the weather cleared up, and the prevailing clouds became cirrus, cumulus, and stratus. At Port Blair, during the same period, the weather was mostly wet or showery; but it got worse from the 10th to the 12th. On the latter date 1·12 inches of rain fell.

Indications of the approach of the cyclone.—Calcutta.—Up to the early morning of the 15th of October there was nothing in the behaviour of the barometer at Calcutta or in the character of the weather to foreshadow the approach of a cyclone, with the exception of the prevalence of north-easterly winds. During the forenoon, and for the greater part of the afternoon of the 14th, the wind was very light from N.E., and the sky, with the exception of a few patches of cirrus, was cloudless. About 4 o'clock in the afternoon the wind suddenly veered to the E. and S.E., the breeze freshened, and the sky became overcast with cumulo-stratus. In a short time, however, the wind calmed and the sky became clear overhead. At 4 P.M., the barometer stood at 29·749 inches, reduced for temperature, showing a rise of 0·044 since the same hour of the previous day. At 10 P.M. the rise, since the same hour of previous day, was reduced to 0·002; and at 4 A.M., of the 15th, there was a fall of 0·038 shown. I find from my note-book that at 2-10 A.M. of the morning of the 15th, there was a sudden slight rain squall from N.E. This struck me at the time as peculiar and threatening, but it only lasted for a few minutes, after which the wind again fell light from the same quarter.

From daybreak on the 15th the appearance of the weather became threatening in Calcutta. The sky was overcast; the wind was from E.N.E., and scuds from the same quarter moved across to W.S.W. Up to 10 A.M., however, the barometer fell very slightly; in fact, the actual fall (0·045) since the same hour of the previous day was almost exactly equal to the rise shown up to the evening before.

As the day advanced, the appearance of the weather became much worse. Low, dark, elongated masses of clouds floated by rapidly from E.N.E., and there were frequent heavy showers of driving rain. At 4 P.M., the wind was E. by N.—velocity 17 miles per hour—blowing in fitful gusts and

varying in direction from E.N.E. to E. The barometer had fallen 0·134 since the previous day, 1·27 inches of rain had been registered since the morning, and it was at this time evident that a cyclone was passing not far distant from Saugor Island.

From the above it will appear that at Calcutta there were no general weather indications of a cyclone before the early morning of the 15th, and no decided fall of the barometer (one which could be distinguished from an ordinary barometric variation) until the afternoon of the same day, when the centre of the cyclone was not more than 100 miles distant, and about 10 or 12 hours before the time when it was nearest to Calcutta.

Saugor Island.—Up to the night of the 14th the barometer at Saugor Island gave no indication of the coming storm. At 10 A.M. there had been a very slight fall from the same hour of the previous day, 0·010; but at 4 P.M. there was a slight rise, 0·004. The general indications of bad weather, however, appeared earlier and were more marked than in Calcutta. In the forenoon the wind was light—mean velocity 6·4 miles—from N.E., and the sky was blue, but partially covered with stratus and afterwards nimbus. From 10 A.M. the sky became overcast and clouds moved across from the N.E. At 4 P.M. there was thunder and drizzling rain, and the mean velocity of the wind had increased to 16·3 miles per hour. From this hour, however, to 10 P.M., the mean velocity of the wind decreased to 7·6 miles; and the commander of the ship *Mistley Hall*, at anchor at the time in Saugor Roads, states that it was calm at sunset, but that there was every appearance of an approaching cyclone, although the barometer had not fallen, and that the sky continued lurid for long after sunset. By 10 P.M. the barometer had only fallen 0·028 since the same hour of the previous day. By 4 A.M. of the 15th the barometer showed a fall of 0·119 since 4 A.M. of the 14th, and the mean wind velocity had again increased to 12·2 miles an hour. The commander of the *Mistley Hall* states that there was a strong breeze from N.N.E. with squalls, and a very stormy appearance at sunrise. The Observatory gives the wind direction as N.E. However, the direction changes always considerably in the squalls before and during a cyclone, and the mean direction of the wind was probably N.E. at this time. At 10 A.M. the barometer had fallen 0·201 since 10 A.M. of the 14th. The velocity of the wind at this hour is not recorded, but between 11-30 and 12 o'clock its mean value was 33·8 miles an hour. The direction of the wind at 10 A.M. was N.E., with squalls and scuds from the same quarter, and 1·48 inches of rain had fallen since 4 A.M.

From the above it will appear that at Saugor Island, on the afternoon and evening of the 14th, indications of the existence of a cyclone in the Bay were afforded by the direction of the wind, the drifting of the clouds, and the general appearance of the weather; but that there was no decided fall of the barometer before 4 A.M. on the morning of the 15th, when the centre of the storm was about 115 miles distant and about 13 hours before it was nearest to Saugor Island. All the indications of the approaching cyclone were thus noticeable at Saugor Island about 12 hours earlier than at Calcutta.

False Point.—From the meteorological register kept at False Point, I gather the following regarding the approach and passage of the storm at that place. From the 11th October the barometer, which before that date had been rising, commenced to fall slowly. The fall up to 10 A.M. of the 14th was altogether 0·115 from 10 A.M. of the 11th, and 0·050 from 10 A.M. of the 13th. At 4 A.M. of the 14th it was calm, but by 10 A.M. there was a strong breeze from the N.E., and the weather was threatening (described as "dirty"), with thunder and lightning. At 4 P.M. the barometer showed a fall of only 0·014 since the previous day, but at 10 A.M. the fall was 0·072. The same kind of weather continued throughout the day, with heavy rain in the evening. At midnight it was blowing a gale of wind, direction not given; but at 4 A.M. of the 15th the wind had backed from N.E. to N.N.W. At this hour the fall of the barometer was 0·171, and at 10 A.M. 0·177. At the latter hour the wind had gone round to N.W., blowing very strong in squalls, with very

heavy rain throughout. By 4 P.M. the wind had further backed to the W. but was still blowing strong in the squalls. The fall of the barometer, reckoned from the same hour of the previous day, was at this hour, however, reduced to 0·119, and after this the barometer rose, and the wind moderated.

It will be seen from the above that at False Point the indications of bad weather were first apparent on the forenoon of the 14th, but there was no remarkable fall of the barometer until about midnight, when it was commencing to blow a gale of wind, and when the centre of the storm was about 110 miles distant. False Point was about 67 miles distant from the nearest point of the mean track of the centre of the cyclone, which passed due east of that place about 8 o'clock on the morning of the 15th. Telegraphic communication with False Point might have given, under favorable conditions, from 20 to 24 hours' notice of the storm in Calcutta, before the centre was nearest to the latter place. At Cuttack, 50 miles inland from False Point, the storm was quite unfelt.

SECTION II.

Progress of the Cyclone up the Bay of Bengal.

I have been able to obtain but little information regarding the origin of this cyclone and its progress up the Bay before its arrival near the Sandheads. It appears that there were unusually few ships at the time along the part of the Bay which the cyclone must have travelled previously to noon of the 14th. The *Ireshope* and the *Patrie* came up the Bay immediately before the storm, and were caught by it near the Sandheads. The *Udston*, coming up the Bay, overtook the gale round the cyclone on the night of the 13th in about latitude 17° N. The S. S. *Scotia* was north of the Andamans on the 14th, near the Cocos, and at the same time the S. S. *Sirius* was in lat. 12° 27′ N., long. 84° 39′ E. Neither of these vessels was ever near the cyclone, but the extracts from their logs are interesting as showing the state of the weather at a distance from the storm, and after it had passed by.

There were three Arab ships in the Bay, which were all caught in the cyclone—the *Chanticleer*, *Fazel Carreem*, and *Humáyún Shah*; but their logs, which are principally taken up with accounts of prayers, devils on the masts, and phantom ships, throw but little light on the phases of the storm. Besides these, I have not heard of any vessels that were in the north of the Bay about the time of the passage of the cyclone. The following are extracts from the logs of the ships mentioned above* :—

Data.—Extracts from Logs of Ships.

Ireshope.

4th October.—Noon.—Light breeze, wind W. 1 P.M.—Moderate W. wind and fine 8 P.M.—Cloudy, wind W. Midnight.—Squally; wind S.W. Lat. 1° 29′ N., Long. 87° 19′ E., at noon.

5th October.—3 A.M.—Hard squalls and rain; wind S.W. Noon.—More moderate. 1 P.M.—Fresh breeze from S.W., and more clear. 8 P.M.—Squally from S.W. Midnight.—Fresh breeze and cloudy. At noon, Lat. 4° 29′ N., Long. 87° 48′ E.

6th October.—5 A.M.—Fresh breeze and fine. Noon.—Brisk breeze and fine. 1 P.M.—Wind S.W.; strong monsoon, and cloudy. 8 P.M.—Squally. At noon, Lat. 8° 2′ N., Long. 88° 49′ E.

7th October.—4 A.M.—Passing showers of rain. Noon.—Moderate, steady breeze and fine, wind S.W. 1 P.M.—Brisk breeze from W.S.W., and fine. 7 P.M.—Squally. 10 P.M.—Struck with a heavy squall, much lightning, and heavy rain. At noon, Lat. 11° 34′ N., Long. 89° 38′ E.; courses northerly.

8th October.—4 A.M.—More clear. Noon.—Fresh breeze and cloudy; wind W.S W. 1 P.M.—Passing squalls. 8 P.M.—Wind W., light air, and cloudy.—Midnight.—Light airs. At noon, Lat., by account, 14° 54′ N., Long., by account, 89° 48′ E.

9th October.—1 A.M. to 4 A.M.—Wind W.N.W., light airs. 5 A.M. to 6 A.M.—Wind S.S.W., gentle airs. Noon.—Gentle breeze and very sultry. 1 P.M.—Variable winds and very sultry. 6 P.M.—Wind S.S.W. Midnight.—Light variable airs. Lat. at noon 16° 12′ N., Long. 89° 52′ E.

10th October.—4 A.M.—Gentle airs from E. 6 A.M.—Wind S.S.E. 9 A.M.—A current setting to the northward, one knot per hour. Noon.—Same wind and very sultry. 1 P.M.—Wind S.S.E., gentle airs, and calm, sultry weather. Midnight.—Winds variable. At noon, Lat. 17° 8′ N., Long. 89° 45′ E.

11th October.—1 A.M —Calm and clear. Noon.—Variable airs and extremely sultry. 1 P.M.—Wind N.N.W., light variable airs, and sultry. 6 P.M.—Wind N. 8 P.M.—Wind N.N.E. Midnight.—Barometer 30·30, light winds, and fine clear weather. At noon, Lat. 17° 30′ N., Long. 89° 41′ E.

* For the logs of these vessels I am indebted to the harbour-master of the Port, Captain Falle, who spared no trouble in endeavouring to collect them. This was, however, no easy matter. Although some masters of vessels courteously placed their log-books at my disposal, there were others who entertained strong objections either to lend their log-books or to furnish extracts from them, and it was not until about six weeks after the storm that some of the most important information was secured after considerable difficulty.—W. G. W.

12th October.—1 A.M.—Wind N.E. 7 A.M.—Wind N.N.E. Up to noon, very light winds and sultry weather. 1 P.M.—Light wind from N.N.E. and very fine clear weather. 8 P.M.—Passing showers of rain. Midnight.—Barometer 30·32, light winds and fine. At noon, Lat. 18° 8′ N., Long. 89° 30′ E.

13th October.

Hour.	Courses.	Winds.	Barometer.*	Remarks.
1 A.M.	N. by W.	N.E. by E.	.....	Same weather.
6 A.M.	.....	Var.	.....	Var. winds and cloudy. Tacking ship occasionally.
Noon	.....	Var.	30·31	Var. winds, rain and threathening appearance.
	Course N.32W., Lat. 18° 49′ N., Long. 89° 1′ E.; dist. per log, 60 miles.			
1 P.M.	E. by S.	N.E. by N.	.....	Passing moderate squalls and rain.
2 P.M.	N.W.	.....	.....	Wind more settled. Tacked ship to the N.W.
3 P.M.	"	N.N.E.	.....	
4 P.M.	N.W. by N.	"	.....	
8 P.M.	"	"	30·27	Fresh breeze and cloudy.
Mid.	N.W.½N.	"	.....	Passing squalls.

14th October.

6 A.M.	N.W.½N.	N.E.	30·26	Increasing squalls. Furled small stay-sails and royals.
8 A.M.	E.S.E.	"	.....	Tacked ship.
9 A.M.	"	"	30·00	Heavy squalls and much rain. Furled top-gallant sails.
?	"	"	29·80	A high N.E. sea rising. Ship pitching very heavy and taking much water over all. Furled the cross-jack and main top-mast stay-sail, and upper mizen top-sail.
Noon	"	"	29·75	
	Course N.37W. ? Lat. by acct., 19° 53′N. ? Long. 88° 12′ E. ?			
1 P.M.	"	"	29·65	Squalls increasing and continued heavy rain. Sent down all studding sail booms.
6 P.M.	"	"	.....	Terrific squalls. Furled upper top-sails and courses.
7 P.M.	S.S.E.	E.N.E.	29·00	Handed the inner jib. Clewed up and furled the lower mizen top-sail and ran the ship away before the wind.
8 P.M.	.....	.....	.....	Furled the lower foretop-sail.
10 P.M.	S.	N.	28·00	Heavy gale with terrific squalls.
11 P.M.	S.E. by S. to N.N.E.	N. to N.W.	28·85 to 28·91	Wind veering to N.W. in a terrific squall. The sea falling considerably. Deemed it prudent to bring the ship to the wind on starboard tack.

15th October.

1 A.M.	S.E. by S.	N.W.	29·30	Wind veering to N.W. in a terrific squall. The sea falling considerably. Deemed it prudent to bring the ship to the wind on starboard tack.
2 A.M.	"	"	.....	Passing frightful squalls.
4 A.M.	N.N.E.	.....	29·65	Hurricane taking off. Set the lower foretop-sails and steered N.N.E.
8 A.M.	.....	.....	.....	Set the upper top-sails and fore-sails.
11 A.M.	.....	.....	29·70	Set the main-sail and inner jib.
Noon	.....	.....	29·72	Ship rolling and shipping very heavy water on board. Barometer rising gradually.
	Course S.53E., Lat. 19° 6′ N. Long. 89° 48′ E.; dist. per log, 131 miles.			
1 P.M.	N.N.W.	S.W.	.....	Fresh breeze and high cross sea.
Mid.	N.W. by N.	.....	.....	Brisk breeze and cloudy.

16th October.—9 A.M.—Wind S.W., steered N.E. Noon.—Fine; steered N.N.E. At noon, Lat. 20° 35′ N., Long. 88° 28′ E. 1 P.M.—Winds S.S.W.; light breeze and fine. A strong current setting to S.W., 5 miles per hour.

Patrie.

5th October.—From 1 A.M. to 4 A.M.—Fine weather and smooth sea; irregular variable breeze. At 5 A.M. a squall with rain, but not much wind. 9 A.M. to noon.—Same weather, rain and squalls with a freshening breeze; winds S.W. to W. At noon, Lat. 5° 59′ N., Long. 91° 44′ E. 1 P.M. to 4 P.M.—Wind W.; courses northerly; overcast weather and heavy squalls; appearance bad. 9 P.M. to midnight—Strong breeze and overcast.

6th October.—1 A.M. to 4 A.M.—Sky always overcast, and breeze not less strong. 5 A.M. to 8 A.M.—Same weather; squalls frequent and at times violent. 9 A.M. to noon, same weather, but squalls less frequent. Lat., by account 9° 15′ N., Long., by account, 90° 54′ E. 1 P.M. —Barometer 29·922, weather overcast. At 1 P.M. a violent squall. 5 P.M. to 8 P.M.—Same weather; bad appearance. 9 P.M. to midnight.—Sky always overcast; lightning vivid and frequent.

7th October.—1 A.M. to 4 A.M.—Same weather, strong breeze, nothing new. 5 A.M. to 8 A.M.—Wind W.S.W. and variable, continued squalls; rain in torrents; lightning without interruption. Lat. 11° 32′ N., Long. 90° 26′ E. 1 P.M. to 4 P.M.—Winds W.S.W. and

* Readings taken from an aneroid which is evidently set much too high. The aneroid has not been compared, hence the observations are useless except in so far as they show variations of pressure.—W. G. W.

variable; good breeze, but uncertain; cloudy weather. 5 P.M. to 8 P.M.—The same. 9 P.M. to midnight.—Dark weather and squalls; continuous rain.

8th October.—1 A.M. to 4 A.M.—Rain; wind very variable in force and direction. 5 A.M. to 8 A.M.—Weather a little clearer and breeze lighter. 9 A.M. to noon.—Weather become fine and settled; all sail possible; wind W. Lat. 14° 10′ N., Long. 89° 16′ E. 1 P.M. to 4 P.M.—Winds W. and variable; courses northerly; barometer at 1 P.M. 29·922. Fine weather and smooth sea; light breeze, all sail possible. 5 P.M. to 8 P.M.—Same weather, then a squall from W. 9 P.M. to midnight.—Same weather, nothing new.

9th October.—1 A.M. to 4 A.M.—Same weather. 5 A.M. to 8 A.M.—Wind S.S.W., same weather; breeze freshening a little. 9 A.M. to noon.—Wind W.S.W.; the wind has veered a little; light breeze, very irregular; fine weather. Lat. 15° 38′ N., Long. 88° 48′ E. 1 P.M. to 4 P.M.—Wind W.S.W.; courses northerly; fine weather and smooth sea. 5 P.M. to 8 P.M.—Same weather; breeze much lighter and almost calm. 9 P.M. to midnight.—Calm.

10th October.—1 A.M. to 4 A.M.—Same weather; calm. 5 A.M. to 8 A.M.—Wind gone round to the S., same weather. 9 A.M. to noon.—Wind S., same weather. Lat. 16° 46′ N., Long. 88° 32′ E. 1 P.M. to 4 P.M.—Courses northerly; winds variable from S. to W.; fine weather; calm, or slight squalls; variable and irregular. 5 P.M. to 8 P.M.—Winds W. and W.N.W., breeze a little stronger. 9 P.M. to midnight.—Same weather, wind W.

11th October.—1 A.M. to 4 A.M.—Same weather. 5 A.M. to 8 A.M.—Winds W. and N.W., same weather. 9 A.M. to noon.—Wind N.N.W., same weather. Lat. 17°30′ N., Long. 88°34′ E. 1 P.M. to 4 P.M.—Wind N.N.W., course N E., weather and sea fine. 5 P.M. to 8 P.M.—Winds N.N.W. and N., course E.N.E., same weather; wind veered to N.E. at 8 P.M. 9 P.M. to midnight.—Winds variable from N.N.E. to N.E., course N.W., afterwards E.S.E.; same weather. Captain Keiner, the Commander of the *Patrie*, remarks on this day: "The weather is uncertain; winds variable from N.W. to E., and squally. The sea very tranquil, but the sun a blood red on the horizon when setting; clouds of different sizes detached one from the other passing with great velocity. These observations indicate a cyclone."

12th October.—1 A.M. to 4 A.M.—Winds N.E. and E.N.E.; courses E.S.E., and N.¼N.W., same weather. 5 A.M. to 8 A.M.—Same winds; course N.N.W., weather the same; winds always variable and gusty. 9 A.M. to noon.—Same; wind veered to N. at 10 A.M. Lat. 17°58′ N., Long. 88° 54′ E. 1 P.M. to 4 P.M.—Winds N. and variable; course E.N.E.; barometer at 1 P.M. 29·76. Fine weather, light irregular breeze. 5 P.M. to 8 P.M.—Wind N.N.E., variable and N.E.; courses E.S.E. and N.N.W.; sky very black in the S.W. and frequent lightning. 9 P.M. to midnight.—Wind N.E., course N.N.W., weather cloudy, and frequent lightning at different points of the horizon.

13th October.—1 A.M. to 4 A.M.—The same weather. 5 A.M. to 8. A.M.—Wind N.E., course N.N.W.; at day-break, sky very black in the S.E. 9 A.M. to noon.—Wind N.N.E., and variable in the gusts; course N.W.¼W. Lat. 19° 27′ N., Long. 88° 34 E. 1 P.M. to 4 P.M.—Wind N.E., course N.N.W.; at first fair weather and smooth sea; at 2 P.M. a squall of bad appearance and sufficiently violent. 5 P.M. to 8 P.M.—Fair weather. 9 P.M. to midnight.—Wind N.E. and variable; same weather; strong breeze and rain.

14th October.—1 A.M. to 4 A.M.—Same wind; course N.N.W.¼N.; at 4 A.M., E.¼S. 5 A.M. to 8 A.M.; at 5 A.M., wind N.N.E.; course E.S.E.; breeze freshening; at 7 A.M. a very violent squall; at 8 A.M., wind round to E.N.E; course N.¼E. 9 A.M. to noon.—Wind same; course N.; heavy rain and continual squalls; weather getting very bad; squalls succeed one another every instant, but the sea not increasing. Lat. 20° 37′ N., Long. 88° 6′ E. 1 P.M. to 4 P.M.—Wind E.N.E.; course N., and from E.S.E. to S.S.E. 1 P.M., Barometer 29·76; 3 P.M., barometer 29·73; weather dark and rainy; squalls continually and for the most part very violent; very bad appearance. 5 P.M. to 8 P.M.—Wind N.E.; courses from E.¼S. to S.E.¼E.; barometer at 5 P.M., 29·69; weather nothing better. At 6 P.M. the barometer, which had been mostly stationary, commenced to fall rapidly. 9 P.M. to midnight.—Wind E.N.E.; course S.E.; wind blowing with hurricane force; sea rising rapidly; barometer at midnight, 29·65; wind very violent.

15th October.—1 A.M. to 4 A.M.—Wind E.; course S.E. to S. 2 A.M., barometer 29·49; 4 A.M., barometer 29·33; wind still more violent; heavy sea; barometer falling rapidly.

Hours.	Winds.	Courses.	Barometer.*	Remarks.
5	E.	S.	28·94	Tempest in all its fury. At 11 A.M. the lull of the centre was felt, and lasted 15 minutes, after which the storm re-commenced with more violence than before.
6	"	S.S.E.	28·74	
7	N.W.	"	.....	
8	"	"	28·35	
9	W.	"	28·15	
10	W.S.W.	N.W.	28·54	
11	S.W.	"	28·74	
12	"	"	29·13	

* The barometric readings were taken from an aneroid which has not been compared. I have reduced the original readings which were in millimetres, to inches.—W. G. W.

1 P.M. to 4 P.M. —Wind S.W.; course N.W., at 1 P.M. barometer 29·33., at 3 P.M. barometer 29·41. The wind continues to blow with the force of a tempest, although the barometer rises sufficiently rapidly. 5 P.M. to 8 P.M.—Wind S.W.; course N.W.; barometer 29·45, 29·49, 29·61, and 29·65. Towards 6 P.M. the sky begins to clear on the S.W., and gives us a little hope. 9. P.M. to midnight.—Winds S.W. and W.S.W.; weather moderated; sea still high; course S.E.¼S. At midnight, barometer 29·73.

The above account is translated from the log of the *Patrie*. Captain Keiner has sent me another account, which differs considerably as regards time. He says:—

"At 5 A.M. barometer 28·94; wind furious. The wind not veering makes me see that I am on the track of the centre of the cyclone; but by running to the S.S.W., although perhaps, I may avoid the centre, I shall probably run on shore at False Point or lower down. At 6 A.M. barometer 28·74; at 7 A.M. barometer 28·35; at 8 A.M. 28·15. At this hour the wind was blowing with all its fury. From 10 A.M. to 11 A.M. I had a lull. The winds hauled N., then N.W. and S.W. At this last point the force of the wind re-commenced. At 10 A.M. the barometer commenced to rise, 28·54.; at 11 A.M. 28·74; at noon 29·13. Towards 2 P.M. the tempest commenced to moderate and the squalls became less violent, barometer 29·41."

16*th October*.—1 A.M. to 4 A.M.—Wind S.W.; course S.E.¼S. The weather continues to improve, and the barometer rises more and more. 5 A.M. to 8 A.M.—Wind S.W.; course S.E.¼S. At 5 A.M. barometer 29·80; same weather, sea not so high. At 8 A.M. sighted a pilot brig; asked for a pilot, but was told that they had lost their boats in the cyclone. 9 A.M. to noon.—Wind S.W.; barometer at 10 A.M., 29·82.

Udston.

8*th October*.—Course N., winds W., W.N.W., and W.S.W. Fresh breeze; passing showers at intervals; afterwards, nine knot breeze; fine clear weather. At noon, Lat. 3° 15′ N., Long. 89° 28′ E.; barometer (aneroid uncompared) 30·12; wind W.

9*th October*.—Course N.¼E.; winds W. by N. and W.S.W. Moderate breeze and pleasant weather. At noon, Lat. 6° 4′ N., Long. 90° 5′ E.; distance 173 miles; barometer 30·08.

10*th October*.—A.M.—Heavy passing showers; afterwards light breeze and fine. Midnight.—Freshening wind, W.N.W. Noon.—Lat. 8° 39′ N., Long. 90° 51′ E.; distance 164 miles; barometer 30·09; wind W.S.W.

11*th October*.—Courses northerly, winds W.S.W. and W.N.W. A.M.—Clear and warm. P.M.—Light breeze from W.N.W. Sunset.—Weather unsettled looking to the eastward; sky of an olive-green colour. Barometer keeps steady. Midnight.—Clouds rising up from N. and E.; dark and gloomy. Lat. at noon 11° 12′ N., Long. 91° 6′ E.; distance 154 miles; barometer 30·06.

12*th October*.—1 A.M.—Wind changed to the E. for a short time, with very heavy rain; then veered again to the W. 8 A.M.—Rain ceased; a light breeze from W.S.W. Noon.—Wind freshening. Noon.—Lat. 12° 48′ N., Long. 90° 56′ E.; distance 97 miles; aneroid 29·95. P.M., begins with a fresh wind and very unsettled appearance, sharp squalls and heavy rain; barometer 29·95. 4 P.M.—Squall and rain. 8 P.M.—Threatening appearance. Midnight.—Squalls and heavy rain; wind unsteady from W. and N.W.

13*th October*.—4 A.M.—Sharp squalls and heavy rain; overcast and dull. Noon.—Strong breeze and squally, with a threatening appearance. At noon, Lat. 15° 17′ N., Long. 91° 6′ E.; distance 150 miles; barometer 29·90. 12-45 P.M., barometer 29·85; 1-50 P.M., 29·80; 2-30 P.M., 29·78. 2 P.M.—Course N.N.W.; wind W.; fresh breeze, squally with heavy rain. 4 P.M.—Wind W.S.W., less wind; squally and rainy at times; barometer 29·76. 8 P.M.—Breeze freshening. 10 P.M.—Wind S.S.E. Midnight.—Fresh gale and squalls, with drizzling rain.

14*th October*.—4 A.M.—Weather very threatening, and wind veering to S.E.; squally with rain. 8 A.M.—Overcast and dull, with hard squalls and rain and an increasing gale; sea rapidly rising from eastward. Noon.—Gale increasing, with terrific squalls and rain. At noon, Lat. 19° 16′ N., Long. 90° 11′ E.; distance 242 miles; barometer 29·85. 2 P.M.—Wind E., courses N. by W. and N.W. by N.; strong gale and heavy squalls. 6 P.M.—Course N.W.½W.; wind E.; terrific gale, with fearfully high sea.

15*th October*.—10 A.M.—Course S.W. by S., wind S.S.E.; thick and hazy weather with rain. P.M.—Furious gale and mountainous sea. 2 P.M.—Course W.¼S.; wind S.S.W. 4-30 P M., squalls moderating. 6 P.M., gale and sea decreasing. 9 P.M., gale moderate and sea going down. Midnight.—Wind and sea moderating.

16*th October*.—3-50 A.M.—Smooth water and light wind.

S. S. *Scotia.*

From Port Blair towards Calcutta.

October 13*th.*

Hours.	Barometer.*	Thermometer.	Remarks.
4 A.M.	29·66	81	A.M., moderate breeze and squally-looking.
8 A.M.	29·72	83	4 A.M., moderate breeze with passing squalls.
Noon	29·71	83	11 A.M., moderate breeze and fine.
Course from Ross Island S.W., E.¾N., Lat. 8° 43′ *N., Long.* 92° 56′ *E.*			
4 P.M.	29·72	83	1-10 P.M., Sir Hugh Rose's island bearing west, distance 3 miles. 4 P.M., moderate breeze and fine. Barren Island, E.N.E.
8 P.M.	29·77	83	6 P.M. Barren Island, E.S.E. Altered course to N., moderate breeze and squally-looking. 6-30 P.M., squall with rain. Remainder, moderate breeze and fine.
Mid.	29·78	82	
October 14*th.*			
4 A.M.	29·76	82	Moderate, unsteady winds, and fine.
8 A.M.	29·78	84	5-30 A.M., sighted Great Cocos Island. 6-15 A.M. sighted Cocos Light-house; moderate breeze and fine.
Noon	29·78	.....	Moderate breeze and fine.
Lat. 14° 40′ *N., Long.* 93° 8′ *E.*			
4 P.M.	29·77	85	Moderate breeze and fine; all sail set.
8 P.M.	29·80	83	Ditto ditto ditto.
Mid.	29·75	83	Moderate breeze, with passing clouds.
October 15*th.*			
4 A.M.	29·74	83	4 A.M., moderate breeze and fine, with dark clouds rising to S.W. 6 A.M. moderate breeze and cloudy, with passing squalls and rain.
8 A.M.	29·74	84	8 A.M., moderate breeze with passing squalls and rain.
Noon	29·75	85	Noon, moderate breeze and fine; all sails set.
Lat. 17° 39′ *N., Long.* 91° 16′ *E.*			
4 P.M.	29·72	84	1 P.M., moderate breeze and fine, with heavy swell from N.W. 4 P.M., swell from N.W.; ship pitching heavily.
8 P.M.	29·74	83	To midnight, moderate breeze, with a N.W. swell.
Mid.	29·74	83	
October 16*th.*			
4 A.M.	29·75	84	1 A.M. and 2 A.M., dark clouds rising in N.W. with lightning. 3 A.M., moderate breeze with light passing showers.
8 A.M.	29·77	85	Moderate breeze and fine.
Noon	29·76	85	Moderate breeze and fine clear weather.
Lat. 20° 30′ *N., Long.* 89° 29′ *E.*			
4 P.M.	29·77	85	Moderate breeze and squally appearance to the westward.
8 P.M.	29·80	83	8 P.M., saw rocket from the Mutlah light-vessel bearing N.E. about 16 miles. Fresh breeze and fine.
Mid.	29·83	82	Eastern Channel light-ship N.E. by N.¼N.; distance 8 miles.

S. S. *Sirius.*

14*th October.*—Noon.—In Lat. 12° 27′ N., Long. 84° 39′ E., Eastern Channel distant 556 miles. Weather thickening, with the appearance of rain, and a long swell from S.S.E., but no wind. At 8 P.M. a breeze from the westward, when the weather cleared off.

* These barometric readings are all reduced for temperature and corrected to the Calcutta standard. The instrument from which they were taken is a "Board of Trade" barometer, No. 283, by Adie, London.—W. G. W.

15*th October*.—Commences with light winds from the N. and gloomy weather, and a heavy swell from the northward. At noon, Lat. 15° 45′ N., Log. 86° 12′ E., Eastern Channel distant 340 miles. At noon, northerly swell increasing, but no wind. At 4 P.M. the ship was plunging bows under. All this time the weather was clear, with the exception of some large black detached clouds passing quickly across from N.N.W. to S.S.E. The head sea began to go down at 9 P.M., and at midnight the sea was quite smooth and sky clear, with a gentle breeze from S.W.

16*th October*.—Commences with light winds from the S.W., and fine clear weather with a slight swell from S.S.W. At noon, Lat. 19° 10′ N., Log. 87° 27′ E. Eastern Channel distant 123 miles. Light winds and fine clear weather continued until midnight, when the pilot came on board.

Barometric readings,* S. S. *Sirius*.

DATE.	8 A.M.	NOON.	4 P.M.	8 P.M.	MIDNIGHT.
12th	29·99	29·98	29·93	29·90	29·93
13th	29·96	30·03	30·08	30·08	30·08
14th	30·01	29·98	29·93	29·93	29·95
15th	29·98	29·98	30·01	30·03	30·03
16th	29·98	30·00	30·03	30·11	30·08

Translation of extract† of the Log of the Arab ship "Chanticleer."

12*th October*.—A.M.—Light northerly winds (all sail set) with showers of rain. Vessel on port tack. Lat. 16° 56′ N., Long. 88° 41′ E. Noon.—Fresh breeze and cloudy; all sail set. 5 P.M.—In top gallant-sails and royals; increasing E.N.E. wind with rain; barometer 29·90. 10 P.M.—Barometer 29·80; wind still E.N.E. Midnight.—Same winds and weather; vessel under top-sails and fore-sail.

13*th October*.—1 A.M.—Winds north-easterly with heavy rain. Vessel on starboard tack, with whole top-sails and courses; occasional squalls. Lat. 17° 41′ N., Long. 88° 36′ E. Noon.—Same weather. P.M.—North-easterly winds and squally. 10 P.M.—Barometer 29·70; winds variable between E. and N. Midnight.—Same weather.

14*th October*—A.M.—Ditto winds and weather. 8 A.M.—Wind veering to the N.W. with increasing strength and heavy rain; furled all sails; barometer 29·65. Noon, 29·60; winds very variable, with confused sea. Main top-mast went over the side, carrying away mizen top-gallant mast. Vessel running before the wind all day. 8 P.M.—Weather clearing up; winds variable; sea still very high and confused, and vessel rolling heavily, shipping much water.

15*th October*.—4 A.M.—Barometer 29·60; wind N.E., decreasing, and weather clearing up. 8 A.M.—Barometer 29·70; high sea still on; wind N.E. Set top-sails, courses, and fore-and-aft sails. Noon.—Long., by observation, 90° 26′ E., Lat. 17° 52′ N.; wind S., with fine clear weather; sea decreasing, but still confused; barometer 29·90. P.M.—Wind veered round to the N.W., with light airs; sea going down; weather fine and clear; barometer 29·95, at midnight.

Translation of extract‡ of the Log of the Arab ship "Fazel Carreem."

13*th October*.—Noon.—Position, by observation, Lat. 17° 48′ N., Long. 88° 33′ E.; barometer 29·85; winds from the northward; somewhat gusty, with showers of rain. Sunset: same weather, but squally. Furled main-sail and top-gallant sails. At 10 P.M. the wind veered to the N.E., with squalls; in jib spanker and sent main-royal yards on deck. Barometer at this time had fallen to 29·50. Midnight.—Increasing breeze: lowered upper top-sails, which blew away. Wind veering to the eastward. Vessel on the port tack close to the wind.

14*th October*.—Wind E. At 7 A.M., barometer 29·65; wind still from the E., with a high sea; jib-boom carried away. 8 A.M.—Wind shifted suddenly to the W.; at 9 to S.W.; and at 10 to S., with increased strength; barometer 29·45. At this time lost all the sails, blown out of the bolt ropes and sockets. At 11 vessel still on the port tack, having gone round as the wind veered; barometer 29·45. Vessel running before the wind from noon to 6 P.M., when she broached to and came to the wind on the port tack, heading W., wind still S.; barometer 29·45. Sea very confused, making a clean breach over the vessel, and causing

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* Unreduced for temperature, no readings from attached thermometer being given, but corrected to the Calcutta standard. The barometer an ordinary mercurial, maker, J. Graham, London.—W. G. W.

† The barometric readings are unreduced for temperature, but are corrected approximately to the Calcutta standard. The original observations, however, do not appear to have been made with any attempt at accuracy.—W. G. W.

‡ The barometic readings are unreduced for temperature, but are approximatley corrected to the Calcutta standard. The instrument from which the readings were taken is a common old barometer: makers Black and Murray, Calcutta. The original observations, however, do not seem to have been made with any approach to accuracy.—W. G. W.

her to labor heavily, endangering the safety of the masts. Midnight.—Barometer 29·45; winds S.; violent gale; vessel rolling heavily.

15*th October*—1 A.M.—Barometer 29·45; wind S.; high sea; main-mast rolled over the side, and washed both boats overboard, with sails fore-and-aft. Vessel laboring heavily, with all the yards on the mizen-mast adrift, and gear flying about. Daylight, same wind, S. Lost mizen top-mast overboard; commenced to throw cargo overboard. At 8 o'clock, mizen-mast went by the board. 9 o'clock saw the sun; barometer 29·52; vessel in the trough of the sea, rolling heavily. Storm from this time commenced to decrease; still at S. Noon, barometer 29·60; wind S.W., less sea; sun visible. Obtained mean altitude, giving lat. 19° 7′ N., long. 89° 26′ E. (by observation). P.M.—Wind steadily decreasing, with less sea; wind veering to the W.; afterwards variable and fine.

Translation of extract of the Log of the Arab ship "Humáyún Sháh"

14*th October*.—In the name of God, &c. Wednesday, 2nd Ramazán, the 54th day from New Year's Day, 14th October, the 21st of the Virgo, the 40th from Maskat, and the 18th from Alfi (Malabar Coast).

We were well in the morning, &c. In the afternoon, the wind was a little stronger from the *Matla'-ul Ayyúq*. The forecastle of the ship was turned to a point between the *Farqad* and *Násh*. All sails were up, from the top of the masts to the bottom. We went at the rate of four miles. About 7 o'clock P.M., the sky was dark on all four sides. The sails were drawn in. The wind decreased. We turned towards the *Janúb* (S.); the forecastle was directed towards the *Tír*. The sky was overcast. The barometer fell at 10 o'clock. We drew in more sails. After midnight, clouds appeared in the *Matla'-uttír*. The sails were up, on the hind (mizzen) mast. We turned the ship towards N.; the forecastle was pointed to the *Jáh*. At 2 o'clock A M., we saw the Devil on the yards of the middle mast. Clouds came one after the other. The wind was strong. We took down more sails; only the lower sails remained. The vessel could not bear the sails on account of the wind. The waves rose high. At 3 o'clock A.M., the Devil left the yard of the mast. We commenced saying prayers till the morning.

In the morning we were well. At 7 o'clock A.M., the wind got stronger from the *Matla'-ul-Ayyúq*. The barometer (French) 74. We turned towards S.; the forecastle stood between the *Aqrab* and *Iklíl-il Matla'*. Only the lower sails were up, on account of the force of the wind. The clouds were very thick, and it rained. At 9 o'clock, we took down the upper portions of the masts. We took in more sails, but could not take in all on account of the waves, wind, and rain. We were afraid that the sailors might fall in the sea. At 5 o'clock P. M. the barometer was 27·50, French 73·50. We expected the vessel to wreck. The waves came over the deck. May the Lord help us! We intended to throw the cargo overboard. We were afraid of the ship filling with water, as all the lower decks were full. We said prayers. At 8 o'clock P.M., the clouds and the cyclone continued. All lower sails were torn, and the wind blew them far into the sea. At 9 o'clock P.M., our boat was carried off from the left side of the ship. Afterwards, the large mast broke; and soon after the other masts went. The broken part of the main-mast fell on the deck; no other parts fell on the deck. The boat on the right side of the ship was then carried away together with the fastenings. Then the privies went, like everything else that was above the deck. The water below had risen to four feet. The noise of the wind and the rain was very great. We said prayers. The ship was on the point of sinking. The ship was constantly wholly covered by the waves. We all embraced each other and prayed. All cabins were under water. The iron pin of the rudder was carried off.

15*th October*.—Thursday, 3rd Ramazán, 55th day after New Year's Day, 15th October, 22nd day of the Virgo. The wind and rain continued as before. Nothing was left on deck except the stumps of the masts. We expected every minute to sink. About 9 o'clock A.M. we opened the windows and began to throw out cargo. The vessel became lighter, 2 o'clock P.M., more water in the ship. Eleven o'clock P.M., the barometer had been rising. About 12 o'clock, midnight, wind and waves abated. The wind blew no longer from the *Maghrib-ul-Aqrab*, and turned to the direction from where it had blown first. The ship was always between two opposite waves. The waves decreased. The pumps removed the water. The sky cleared up, and the rain abated; but the ship still remained between two waves the, whole day and the first half of the night.

A ship of three masts approached us. We called out, but they did not answer, and passed on to the *Matla'-uttír* for about half an hour. It then turned and came near us. We again called, but it went again away towards the *Maghrib-ul-Ayyúq*. We did not know whether this was a human ship or a ship of the Jins,* for it went sometimes to the W. and sometimes to the E. We saw it for about an hour; we did not see it again till in the morning.

* Ghosts.

We had escaped, and thanked God.

Discussion.

The ships *Ireshope* and *Patrie* crossed the line about the same time, and experienced very similar winds and weather coming up the Bay of Bengal. In the early days of the month of October about the equator and up to latitude 3° or 4° N., the weather was hot and very sultry, with gentle westerly airs. On the 5th October the *Patrie* was in latitude 4° N., when the weather changed. From this date to the 8th the ship made a rapid run up the Bay to between latitudes 13° and 14° N., experiencing throughout dark, overcast weather, with frequent violent squalls, thunder, and lightning, and torrents of rain, and winds mostly from W.S.W., but sometimes from W. From latitude 13° or 14° N., the weather became fine, and the winds very light and variable. The *Ireshope*, crossing latitude 4° N. on the 5th October, also made a rapid run, and experienced the same winds and weather as the *Patrie* up to between latitudes 13° and 14° N., where the weather cleared on the 8th. From the 8th to the 11th the ships made little progress, the winds being light and very variable, and calms frequent. At noon of the 11th both ships were in about latitude 17° 30′ N., some 70 miles apart, and from this time and position had north-easterly winds until after the passage of the cyclone.

The *Udston* crossed the equator on the morning of the 7th October, and had clear weather with a high barometer and light, variable, but mostly south-westerly airs. The weather continued fine, with occasional passing showers and unsteady westerly winds up to the 11th of October in latitude 11° 12′ N. At sunset of the 11th, the appearance of the weather was threatening to the eastward, and the sky of an olive-green colour. At midnight the sky was dark and gloomy, and clouds were rising up to the north and eastward. On the morning of the 12th there was heavy rain, thunder, and lightning, and the general appearance of the weather was very unsettled. At noon of the 12th, the *Udston* was in latitude 12° 48′ N., longitude 90° 56′ E., and from this time and place experienced very bad weather, with strong westerly winds and occasional sharp squalls and heavy rain.

At noon on the 13th the ship was in latitude 15°17′ N., longitude 91° 6′ E., and had a strong freshening breeze from W.S.W. and W.; appearance of the weather threatening, with sharp squalls and heavy rain. At 10 P.M., the wind had backed to S.S.E., and towards midnight increased in force to a fresh gale. On the morning of the 14th the wind backed further round to the S.E., and afterwards (time not stated) there were severe gusts from the E. At noon the gale was increasing, with terrific squalls and rain. The ship had made a rapid run of 242 miles from noon of the 13th to noon of the 14th, when the position by account is given as latitude 19° 6′ N., longitude 90° 11′ E. The changes of wind which the *Udston* experienced are not clearly shown in the log, but it appears probable that the ship overtook the cyclone on the night of the 13th on its eastern quadrant, but at some distance from the centre, in about latitude 17° N., and running a N.N.W. course, nearly parallel to the track of the storm, passed it and got to the N.E. of the centre by noon of the 14th.

At noon of the 13th the *Ireshope* was in latitude 18° 49′ N., longitude 89° 1′ E. The weather on the 12th had been clear and fine, with light, variable, north-easterly airs and passing showers in the evening. The same weather continued on the morning and forenoon of the 13th; but towards noon the weather became threatening, and at 1 P.M. the ship, on a course E. by S., experienced passing squalls and rain. Soon afterwards the course was changed to N.W., and the ship ran into better weather; but it continued cloudy with a fresh breeze from N.N.E. until midnight, from which time the weather got rapidly worse. At 9 A.M. of the 14th the course was altered to E.S.E., and from this time the ship experienced an increasing gale from N.E. with squalls and heavy rain. The latitude at noon is given at 19° 53′ N., the longitude is doubtful; but it was probably about 88° 12′ E., the course being given as N. 37° W. from the previous noon.

At noon of the 13th the *Patrie* was in latitude 19° 27′ N., longitude 88° 34′ E. The weather on the 12th was fine, with light, irregular, north-easterly winds. The same weather continued to about 2 P.M. of the 13th, when it became squally, wind mostly north-easterly, but varying considerably in the squalls. At 5 A.M. of the 14th the ship, which had been on a N.N.W. course, tacked to the S.S.E., and had a freshening breeze, with occasional squalls from N.N.E. and N.E. At 8 A.M. the wind veered to E.N.E., and the ship tacked to the N. From this to noon the squalls became more frequent, and were accompanied by heavy rain. The position of the ship at noon on the 14th is given as latitude 20° 37′ N, longitude 88° 6′ E, or about 30 miles S.byW. from the Eastern Channel Light.

The logs of the Arab ships *Chanticleer* and *Fazel Carreem* give but little information which can be regarded as accurate about the passage of the storm. Little reliance, I think, can be placed on some of the wind observations, and less still on the barometric readings. However, the positions of these ships, and the changes of wind which they experienced, combined with more reliable data, are useful in giving an approximate idea of the course of the cyclone at sea.

The *Chanticleer*, in latitude 16° 56′ N., longitude 88° 41′ E., at noon of the 12th, had light northerly winds in the morning, with showers of rain; all sails set. In the afternoon, the wind freshened, and by 5 P.M. the vessel was under top-sails and fore-sails, with a strong increasing wind from E.N.E. The weather appears to have got worse on the 13th; wind north-easterly, with squalls and heavy rain. At noon, latitude 17° 41′ N., longitude 88° 36′ E.; distance from noon of previous day about 52 miles N.$\frac{1}{2}$W. At 8 A.M. of the 14th, the wind was backing to the N.W. with increasing strength and heavy rain. The ship was probably at this time in about latitude 18° 15′ N., and on the western quadrant of the storm. All sail was now taken in, and for the remainder of the day up to 8 P.M. the vessel was driven before the wind, first to the southward and then to the eastward, as the wind changed. After 8 P.M. the weather cleared up, but the sea continued high and confused. It is remarkable that on the forenoon of the 15th, after the storm had passed away, the wind directions are again given as north-easterly. That such was the case is not improbable, as the wind was N.E. at the same time at Port Blair. At noon of the 15th, the *Chanticleer* was in latitude 17° 52′ N., longitude 90° 26′ E.; wind S., with fine, clear weather, but a high confused sea. The course which the ship appears to have made round the south-western quadrant of the cyclone is consistent with the above position at noon of the 15th.

At noon of the 13th, the *Fazel Carreem* was about 12 miles N.W. of the *Chanticleer*, in latitude 17° 48′ N., longitude 88° 33′ E., and had northerly gusty winds, with passing showers of rain. Towards sunset the wind got squally, and by 10 P.M. had veered to N.E. At midnight there was an increasing breeze, veering to the eastward, and the barometer was falling rapidly. The ship was now on the northern quadrant of the storm, and appears to have got into the central calm between 7 A.M. and 8 A.M. of the 14th, as at 8 A.M. the wind suddenly shifted to the W. No lull, however, is recorded in the log. At 9A.M. the wind was S.W., and S. at 10. About this hour all the sails were blown away, and the vessel was driven before the southerly wind up to 6 o'clock in the evening. From this time the wind appears to have moderated, and the vessel, with all her masts and yards adrift, seems to have suffered more from the high sea, which continued up to noon of the 15th, than from the force of the storm. At noon the ship was in latitude 19° 7′ N., longitude 89° 26′ E.

Before attempting to infer the probable position of the cyclone at noon of the 14th from the above data, it must be pointed out that the information derivable from the logs of the ships *Ireshope* and *Udston*, upon which I have mainly to rely, is extremely scanty and unsatisfactory, and the positions of the ships are only estimated by account, and may be considerably in error. The *Udston* appears to have had a strong gale from S.E., with severe squalls and very heavy rain. At the same time the *Ireshope* had a heavy gale from N.E., with violent

squalls, very heavy rain, and a rapidly falling barometer. Accepting the positions of the ships, as given in the extracts from the logs at this time, as correct, and taking ten points to the right from the direction of the wind as the bearing of the centre of the cyclone, its position at noon of the 14th would be about latitude 18° 44′ N., longitude 88° 38′ E. This position would place the *Udston* at a distance of about 100 miles and the *Ireshope* about 80 miles from the centre. These distances are not improbable from the circumstances at the time and the subsequent courses of the ships and the storm. It is tolerably clear from the fall of the *Ireshope's* barometer that the centre of the storm could not have been very far distant at this time. The account of the weather given is not very full, but even the *Patrie*, about 57 miles N. by W. of the *Ireshope*, was at this time experiencing very bad weather and violent squalls from N.E. and E.N.E. On the other hand the *Udston's* barometer seems to have fallen but slightly, and the ship, up to this time, appears to have been keeping on the outer circumference of the gale round the body of the storm, at a considerable distance from the centre. On the afternoon of the same day, however, the course having been changed from N. by W. to N.W., the ship ran much nearer to the centre and had a "terrific gale with a fearfully high sea." The position given above for the centre of the storm at noon of the 14th, even supposing the ship's position to be correctly stated, can only be taken as approximate. It appears to be consistent, however, with the general course of the storm and the courses of the ships which have been reviewed. The exact direction of the wind at the *Udston* at the time is, however, uncertain. I have taken it as S.E. There is no change of wind given in the log up to 2 P.M., when it was E. During the forenoon it is given as S.E.

From noon of the 14th the account of the storm given in the log of the *Udston* is even more meagre than before. At 2 P.M., the course was changed from N. by W. to N.W., and the ship approaching the cyclone on its north-eastern quadrant had a "terrific easterly gale and a fearfully high sea." On the morning of the 15th the ship was heading S.W. by S., and afterwards S.W. with wind S.S.E., and had got back to the eastern side of the storm. At 2 A.M. the ship had got further round on a westerly course to the south-eastern quadrant, and experienced a furious gale, mountainous sea, and squalls of hurricane force from S.S.W. At 4-30 P.M. the squalls were moderating and the gale and sea rapidly decreasing. The *Udston* had a cargo of horses from Melbourne. A number of the horses broke adrift during the cyclone, and kicked each other to death; 142 horses are reported to have thus perished.

In the afternoon of the 14th the *Ireshope*, heading E.S.E., with the wind N.E., encountered the northern quadrant of the cyclone. At 7 P.M. the ship was put before the wind, which was then apparently E.N.E. From this time the ship ran across and round the storm, and had the wind backing through N. to N.W. between 10 and 11 P.M. The lowest reading of the barometer, an aneroid, is given as 28·8. The time when this reading was taken is not clearly shown in the extract of the log which I received, but it was probably about 11 P.M. (The instrument evidently reads at least three-tenths too high, but the exact correction is uncertain. The above reading, however, shows a fall of about 1·46 since the same hour of the preceding day.) The wind was N.W. at 11 P.M., and blowing with hurricane force, but the sea had gone down considerably. The ship was at this time on the south-western quadrant of the storm, and probably, judging from the fall of the barometer, not very far from the vortex. From 1 A.M. the ship was heading S.E. by S. and soon got out of the storm. By 4 A.M. the gale had moderated, and at 6 A.M. the ship, which had run down far to the southward, was able to make sail and steer to the N.N.E., arriving at noon in latitude 19° 6′ N., longitude 89° 48′ E.

On the afternoon of the 14th the *Patrie*, tacking about from N. to S.S.E., had the wind from E.N.E. to N.E., blowing in strong squalls. From 6 P.M. the barometer, which up to this time had been stationary, commenced to fall, and the wind rapidly increased in force. At midnight the wind had veered to the E., and remained at this quarter until 6 A.M. of the 15th. All this time the ship

had been heading S.E., and had probably drifted somewhat to the westward of her longitude at noon of the 14th, as the Captain states that he was unable to avoid the centre (although knowing that he was right on the track of the storm) by changing his course to S.S.W., because of the danger of being driven on shore near False Point, or further south. From about 6 A.M. the *Patrie* seems to have been in the body of the storm and gradually drifting towards the vortex, the wind backing through north to N.W. at 7 A.M., and W. at 9 A.M. The lowest reading of the barometer is put down in the log to 9 A.M., and the captain states that from 10 A.M. the barometer commenced to rise. He also states that he had a calm from 10 A.M. to 11 A.M., after which the wind recommenced to blow with hurricane force from the S.W. There seems to be some confusion here about the time and duration of the central calm. If the winds and barometric readings in the log are given correctly, it would appear that the *Patrie* must have entered the central calm between 8 and 9 A.M., with the wind N.W. or W.N.W., as the barometer was lowest, 28·15 (uncorrected), at 9 A.M., and by 10 A.M. had risen to 28·54. When the wind recommenced from the S.W., the ship was heading N.W., and appears to have been carried along in the body of the storm until about 6 P.M., when the sky commenced to clear and the wind to moderate.

From the foregoing review a general idea may be formed of the progress of the cyclone up the Bay. It will be seen further on, that at 1 P.M. of the 15th the centre of the storm was in latitude 21° N., and longitude 87° 45′ E. This would give a mean rate of progress of a little less than seven miles an hour between noon of the 14th and 1 P.M. of the 15th, and a mean course N.N.W. in the Bay of Bengal.

SECTION III.

Progress of the Cyclone over the Sandheads and the North-Western Corner of the Bay.

The data available for tracing the course of the cyclone over the north-western corner of the Bay of Bengal are sufficiently numerous. The floating light-vessels at the Eastern Channel, Lower Gasper, and Upper Gasper stations, all felt the storm severely on its eastern side, and were all driven off their stations. The Pilot Vessel *Coleroon*, in attempting to put to sea, was driven bodily to the westward and caught right in the centre of the storm. The Pilot Vessel *Cassandra* shared the same fate further out to sea. The S. S. *Sir John Lawrence*, proceeding from Calcutta to Chandbally, encountered the western side of the cyclone near point Palmyras. The floating light-vessel on the Mutlah station experienced only a heavy gale, as the centre of the cyclone passed about mid-way between her position and False Point at a distance of about 65 miles. Extracts from the logs of all these vessels are given below. Also a copy of the log of the ship *Mistley Hall*, at anchor in Saugor Roads, and the report of the Pilot in charge of the American schooner, *Susan E. Vorhes*, at Diamond Harbour. These, with the detailed land observations made at the meteorological stations at False Point and Saugor Island, and the barometrical observations made at Contai by Mr. Taylor, Executive Engineer, Hidgelee Division, form the data for this section, and are given below. The barometers of the *Coleroon* and *Mistley Hall*, were sent to me for comparison with the Calcutta standard, and the corrections obtained have been applied to the original barometric readings. The comparisons, however, could only be made for the ordinary diurnal range of pressure, and hence the corrections cannot be relied upon for low pressures, such as are experienced in a cyclone. The barometers of the other vessels have not been compared, nor has the aneroid from which the readings at Contai were taken.

Extract from Log of the "Coleroon," Pilot Vessel—Commander, Captain G. B. Smart.

Saturday, 10th October 1874.

Hour.	Barometer reduced to 32°, and corrected.	Thermometer.	Wind.	Force.	Weather.	Position.
2	29·77	83	E.S.E.	Light	Fine	E. C. Light, N.E.
4	·77	83	East	„	Cloudy	At anchor.
6	·77	84	S.E.	„	Fine	„
8	·87	85	East	„	„	„
10	·86	86	E.N.E.	„	„	„
Noon	·86	88	East	„	„	„
2	·82	89	„	„	„	„
4	·81	88	E.N.E.	„	„	„
6	·84	87	S.E.	„ air	Calm	„
8	·83	86	„	„ „	Lightning to the N.W.	„
10	·82	85	„	„ „	Fine	„
Midnight	·82	85	„	„ „	„	„

Sunday, 11th October 1874.

2	29·82	85	S.E.	Light	Fine	E. C. Light, N.E.
4	·82	85	„	„	„	At anchor.
6	·83	84	„	„ air	Calm	„
8	·89	85	Calm	Calm	Fine	„
10	·86	86	N.E.	Light air	Calm	„
Noon	·86	86	North	„ „	„	„
2	·81	88	„	„ „	Rain	„
4	·78	89	S.E.	„ „	Fine	„
6	·76	88	Calm	Calm	„	„
8	·76	87	„	„	„	„
10	·76	87	„	„	„	„
Midnight	·76	87	„	„	„	„

Monday, 12th October 1874.

Hour.	Barometer reduced to 32°, and corrected.	Thermometer.	Wind.	Force.	Weather.	Position.
2	29·77	85	Calm	Calm	Fine	E. C. Light, N.E.
4	·79	85	,, ...	,, ...	,, ...	At anchor.
6	·77	85	North	Light air ...	,, ...	,,
8	·83	85	,, ...	,, ,, ...	Squally to S.E., with thunder and lightning.	,,
10	·85	85	,, ...	,, ,, ...	Rain	,,
Noon	·82	84	East	,, ,, ...	Rain	,,
2	·77	85	S.E.	,, ,, ...	Fine	,,
4	·76	88	North	,, ,, ...	,, ...	,,
6	·76	87	N.E.	,, ,, ...	,, ...	,,
8	·76	86	,, ...	,, ,, ...	Lightning to southward and eastward.	,,
10	·77	85	,, ...	,, ,, ...	Lightning to southward and westward.	,,
Midnight	·77	85	,, ...	,, ,, ...	Lightning to southward and westward.	,,

Tuesday, 13th October 1874.

2	29·77	85	S.E.	Light	Fine	E. C. Light, N.E.
4	·77	85	South	,, ...	,, ...	At anchor.
6	·78	82	N. by W. ...	,, ...	,, ...	,,
8	·82	84	N.N.E.	,, ...	,, ...	,,
10	·82	84	,, ...	Moderate ...	,, ...	,,
Noon	·82	85	,, ...	,, ...	,, ...	,,
2	·82	87	N.E.	Light	,, ...	,,
4	·75	88	N.N.E.	,, ...	,, ...	,,
6	·76	86	E. by N.	,, ...	Cloudy	,,
8	·76	86	East	,, ...	Fine	,,
10	·76	86	E.N.E.	,, ...	,, ...	,,
Midnight	·77	85	N.E.	,, ...	,, ...	,,

Wednesday, 14th October 1874.

2	29·77	83	N.E. by N. ...	Light	Fine	E. C. L. N.E.
4	·77	83	N.E.	Moderate ...	,, ...	At anchor.
6	·77	84	,, ...	,, ...	,, ...	,,
8	·78	85	N.N.E.	Fresh	Cloudy	E.C.L. N. by W.
10	·82	85	N.E	,, ...	Squally	E.C.L. S.S.E.
Noon	·78	84	,, ...	,, ...	Cloudy	
2	·73	83	N.E. by E. ...	,, ...	Heavy rain-squalls ...	At anchor
4	·78	82	N.E.	,, ...	,, ...	E.C.L. S.E.¼S. about 4 miles. Lower Reef Buoy W.N.W. 4 miles.
6	·68	82	N.E. by E. ...	,, ...	Squally with rain ...	At anchor.
8	·69	82	,, ...	Strong	Same weather; rain-squalls	,,
10	·67	83	,, ...	Moderate gale ..	Squally with rain ...	,,
Midnight	·64	83	,, ...	,, ,, ...	Rain-squalls	,,

THURSDAY, 15TH OCTOBER 1874.

Hour.	Barometer.	Thermometer.	Wind.	Force.	Weather.	Position.	REMARKS.
1	29·64	84	N.E. by E. ...	Fresh	Squally	....	At an anchor in the Eastern Channel. Fresh breeze and squally; vessel rolling considerably.
1-30	·62	84	„ ...	Fresh gale	„	Reef Buoy, W.N.W.	Observed the first flash of lightning to the eastward.
2	·60	84	„ ...	„ „	„	E. C. Light S.E.¼S.	Lightning to the northward.
2-30	·57	84	„ ...	„ „	„	„	Heavy squalls; battened down the hatches.
3	·57	84	„ ...	„ „	„	„	Ditto weather.
3-30	·56	84	„ ...	„ „	„	„	Ditto ditto.
4	·56	84	„ ...	„ „	„	„	Ditto ditto.
4-30	·56	84	„ ...	„ „	„	„	Ditto ditto; heavy sea rising.
5	·56	84	E.N.E. ...	„ „	„	„	Hard squalls and a heavy sea.
5-30	·56	84	„ ...	„ „	„	„	Ditto weather ditto ditto.
6	·56	84	„ ...	„ „	„	„	Ditto ditto ditto ditto; very dull and heavy appearance to the S.E.; sent down fore top-gallant yard.
6-30	·56	83	„ ...	Increasing gale ...	„	„	Increasing wind and sea.
7	·56	83	„ ...	„ „ ...	„	„	Very threatening appearance and sea still rising; considered it unsafe to continue at an anchor; shipped from the Ridge anchor at the 7th shackle of the cable (87½ fathoms), and proceeded to go to sea under the reefed fore-sail, reefed fore top-mast stay-sail, fore stay-sail, and storm main-stay-sail.
7-30	29·52	83	E.N.E. ...	Hurricane	Hurricane	Unknown	Increasing in violence and sea also rising.
8	29·52	83	„	„	Cyclonic	„	Increasing to a hurricane; observed the Lower Reef Buoy bearing E.N.E.
8-30	29·48	83	„	„	„	„	Crossing the Eastern Reef, a very heavy sea breaking at the top, threatening to sweep the deck, but the brig behaving admirably as she rose to the sea.
9	29·40	83	„	„	„	„	Increasing to a furious hurricane and a very heavy sea with blinding drift.
9-30	29·36	83	„	„	„	„	Hurricane and sea increasing in force; the fore top stay-sail, fore stay-sail, and storm main stay-sail, split and blew away; the wind in furious squalls.
10	29·28	83	East	„	„	„	Blowing a furious hurricane; the fore-sail split and blew away from the yards, and the brig commencing to put her starboard or lee rail in the water.
10-15	29·12	83	„	„	„	„	Blowing a furious hurricane and a very heavy sea with blinding drift; the brig labouring very much, and continuing to keep her starboard rail in the water, being under bare poles.
10-45	28·96	83	„	„	„	„	Blowing a furious hurricane and a very heavy sea with blinding drift the brig labouring very much, and continuing to keep her starboard rail in the water, being under bare poles.
11-30	28·95	83	„	„	„	„	Blowing a furious hurricane; the sea commencing to make a breach over the vessel and also laying over considerably; considered it unsafe to allow her to remain in that state; cut away the main-mast, which passed under the bottom of the vessel, and she immediately righted and resumed her buoyant state.
Noon	27·88	83	„	„	„	„	Blowing a furious hurricane and a very heavy sea, the brig entirely at the mercy of the storm, and drifting bodily to leeward.

THURSDAY, 15TH OCTOBER 1874.—(*Continued.*)

Hour.	Barometer.	Thermometer.	Wind.	Force.	Weather.	Position.	REMARKS.
0-45	27·78	83	East	Hurricane	Cyclonic	Unknown.	Blowing a furious hurricane and a very heavy sea; the clouds clearing away overhead a little, and the sun faintly showing.
1	27·68	83	,, ...	,, ...	,, ...	,, ...	Quite a sudden lull, and land birds about the vessel.
1-15	27·58	83	,, ...	,, ...	,, ...	,, ...	Nearly a calm; sun visible, and land birds still about the vessel; but a heavy confused sea.
1-30	27·60	83	,, ...	,, ...	,, ...	,, ...	Wind suddenly shifting to S.W., but still nearly a calm, with heavy, confused sea; birds still about the vessel; sounded 18 fathoms, but uncertain of it, owing to the vessel drifting away from the lead; wore round on the starboard tack.
1-45	27·84	83	W.S.W. ...	,, ...	,, ...	,, ...	The hurricane suddenly burst upon the vessel from W.S.W. with more furious force than before the calm, burying the vessel in the water.
2-15	27·86	83	,, ...	,, ...	,, ...	,, ...	Furious hurricane from W.S.W., and howling in its force; the seas breaking on board in succession, and burying her port side in the water, and nearly washing overboard all those on the quarter-deck; the wind blew away the remains of our quarter-boat, and shortly after lifted our large boat from the top of the sheep-pen, and, tearing it away from the gripes and from extra lashings, blew it away clear of the lee rail and into the sea.
2-30	28·10	83	,, ...	,, ...	,, ...	,, ...	Still blowing a furious hurricane, and a very heavy sea; the vessel heading S.E. by compass, with only fore-mast and fore top-mast standing, and drifting away to leeward at the mercy of the wind and waves.
3	28·43	83	,, ...	,, ...	,, ...	,, ...	Still blowing a furious hurricane, and a very heavy sea; the vessel under no control, but only drifting.
3-30	28·56	83	,, ...	,, ...	,, ...	,, ...	Still blowing a furious hurricane, and a very heavy sea; the vessel under no control, but only drifting.
4	28·66	83	,, ...	,, ...	,, ...	,, ...	Still blowing a furious hurricane, and a very heavy sea; the vessel under no control, but only drifting.
5	28·90	83	,, ...	Moderating	Hurricane	,, ...	Moderating in force, but still a heavy sea.
6	29·11	83	S.W.	Heavy gale	Moderating	,, ...	A little more moderate, and not quite so much sea; vessel drifting, a hulk.
7	29·28	83	,, ...	Fresh ,, ...	,, ...	,, ...	Weather moderating.
8	29·40	83	,, ...	,, ,, ...	,, ...	,, ...	Still a heavy sea; the fore top-sail yard, which had been swinging violently by hanging to the top-mast by the top-sail tye, about this time went overboard, taking the top-mast with it; but, being attached by the rigging, remained alongside, striking the side of the vessel.
9	29·48	83	,, ...	,, ,, ...	,, ...	,, ...	Wind moderating, and sea also going down; sounded in 7 fathoms.
9-30	29·52	83	,, ...	Moderate	,, ...	,, ...	Prepared to get the starboard anchor ready. Shoaled into 4 fathoms, and then deepened again into 6 fathoms; let go the anchor and brought up the flashes from the lantern of Saugor Light-House then seen bearing N.N.E.¼E., veered to 60 fathoms of cable, and remained at an anchor.
10	29·60	83	,, ...	Fresh breeze ...	,, ...	Saugor Light-House N.N.E.¼E. ...	At an anchor; wind and sea moderating.
Midnight	29·67	83	,, ...	,, ,, ...	,, ...	Ditto ditto ...	At an anchor; wind and sea moderating; the vessel dismasted.

Friday, 16th October 1874.

Hour.	Barometer.	Thermometer.	Wind.	Force.	Weather.	Position.	Remarks.
2	29·68	82	W.S.W. ...	Moderate	Fine	At anchor in the Western Channel.	Daylight—Turned hands out to clear away the wreck of the fore-top and jibboom; sighted a light-vessel bearing N.N.E.; supposed her to be the Lower Gasper Light; also observed the K. Buoy of the Western Channel bearing N.W.; Channel Middle Ground Buoy S.¼W., and various other buoys to the northward and to the eastward.
4	29·68	82	,, ...	,, ...	,, ...	Saugor Light-House N.N.E.½E. ...	
6	29·68	82	,, ...	,, ...	,, ...	.....	
8	29·68	82	S.W.	,, ...	,, ...	.....	
10	29·78	82	,, ...	,, ...	,, ...	.....	
Noon	29·75	83	West	,, ...	,, ...	.....	2 P.M.—Mr. S. Ranson, Master Pilot, went on the fore-top and observed three light-vessels.
2	29·70	83	S.W. by S. ...	,, ...	,, ...	.....	
4	29·69	84	,, ...	,, ...	,, ...	.....	4-15.—Bent fore-sail and fore stay-sail; a brig-rigged steamer passed down.
6	29·69	83	S.S.W. ...	,, ...	,, ...	.....	8.—Set the anchor watch.
8	29·72	83	,, ...	,, ...	,, ...	.....	9-30.—Showed three blue-lights at intervals of five minutes, and a light at the starboard fore yard-arm.
10	29·72	83	,, ...	,, ...	,, ...	.....	
Midnight	29·67	83	,, ...	,, ...	,, ...	.....	

Saturday, 17th October 1874.

2	29·67	83	West	Moderate	Fine	At anchor in the Western Channel. Saugor Light N.N.E.½E.	
4	29·69	83	N.W.	,, ...	,, ...	Ditto.	
6	29·79	83	N. by W. ...	,, ...	,, ...	Ditto.	
8	29·83	80	,, ...	,, ...	,, ...	Ditto.	
10	29·85	82	N.E.	,, ...	,, ...	Ditto.	
Noon	29·82	85	Westerly ...	Light air	Calm	Ditto.	
2	29·81	86	,, ...	,, ...	,, ...	Proceeding down the Western Channel.	
4	29·75	86	,, ...	,, ...	,, ...	Proceeding to the Eastern Channel.	
6	29·77	85	,, ...	,, ...	,, ...	Ditto.	
8	29·77	85	,, ...	,, ...	,, ...	E.C. Light S.E.½S.	
10	29·75	85	Calm	Calm	,, ...	At anchor.	
Midnight	29·77	85	,, ...	,, ...	,, ...	Ditto.	

Extract from the Log of the Pilot Vessel "Cassandra"—MR. R. SCOTT, *Branch Pilot, Commander.*

October 14th.—4-30 P.M.—Stood to the S.E. to make our position. 8 P.M.—Eastern Channel floating light-vessel, N.E., five miles; strong N.E. wind; barometer 29·87; thermometer 85°. At 11 P.M., barometer 29·40; wind still N.E.; barometer falling.

October 15th.—At midnight called the Commander; took in upper top-sails, spanker, and inner jib, and made them fast. Barometer falling fast; battened down hatches forward. 2 A.M.—Barometer 29·10; screwed on sky-light protections and battened down main hatches. 5-30 A.M.—Found after-weather fore top-mast backstay had carried away; clewed up lower top-sail. In so doing, the sail split; blowing too hard to send hands up to furl it. 7 A.M.—Patent truss of lower main top-sail yard carried away. Clewed the sail up; sail blew out of the bolt ropes. 8-15 A.M.—Fore top-mast carried away, screwing off the head of the fore-mast, and carrying away the jibboom and main top-gallant mast. Barometer 28·50. 8-30.—Strong gale, freshening. 9 A.M.—Violent squalls from eastward. 10 A.M.—Barometer 27·90; aneroid 27·90; a lull for about an hour. Made all the loose spars fast, and cleared a portion of the wreck. During the calm, birds were flying on board, but there was no heavy sea. 11 A.M.—Wind shifted to W.; barometer rising, 28·10. 11-15.—Heavy squalls from the west-ward, which increased to a hurricane. Brig still heading from S. to S.S.E. Noon.—Barometer 28·40; rising rapidly; wind still with tremendous force. 1 P.M.—Barometer rising, 28·60. 3 P.M.—Barometer 28·80; wind moderating. 3-30 P.M.—Barometer 29·15; a heavy sea came over, washing overboard starboard henooop, cover trough, slides, and mooring post. Water appearing muddy; unable to take a cast of the lead on account of wreck on the weather side. 5 P.M.—Set fore and main stay-sails, and also the spanker, close reefed. 8 P.M.—Sounded in 25 fathoms; sand, black and white specks. Midnight.—Fine and clear; barometer 29·70.

October 16th.—4 A.M.—Sounded in 19 fathoms. Daylight.—Cleared away the remainder of the wreck and set the fore-sail; sounded in 25 fathoms. 8 A.M.—Sighted South Channel buoy, bearing N. 9-45.—Sounded in 13 fathoms; mud; steered E.N.E.; light S.W. wind. 11-30.—Sighted lower reef buoy; steered N. by E.; E. C. Light-vessel not in sight. 1-55 P.M.—Took up position of E. C. F. Light.

Extract of a letter from the Commander of the F. L. V. "Meteor" (Eastern Channel Station, Long. 88° 15′ 30″, Lat. 21° 3′ 30″) to the Master Attendant, Calcutta.

I HAVE the honor to report that the *Meteor* encountered a cyclone, commencing at 4 P.M., on the 14th October, wind E.N.E., barometer 29·65, aneroid 29·78, thermometer 84°. Midnight.—Barometer 29·76, aneroid 29·72, thermometer 80°; fresh N.E. gale with a high sea. *15th October.*—4 A.M.—Barometer 29·54, aneroid 29·65, thermometer 80°. 8 A.M.—Barometer 29·46, aneroid 29·60, thermometer 80°; heavy gale, with much rain. Lost sight of the *Coleroon*, which was at anchor N.W. *10h.*—Parted cable, let go the port anchor, but the cable parted; barometer 29·26, aneroid 29·40, thermometer 80°. Owing to the very heavy sea, the chief officer and myself were of opinion that it would have been useless to let go another anchor. Vessel driving N.W.; kept the lead going; sea at times breaking all over the vessel. Noon.—Heavy E.N.E. hurricane, with rain; barometer 29·06, aneroid 29·28, thermometer 80°; vessel rolling very much. The starboard boat filled; cut the boat away. 2 P.M.—Barometer 29·04, aneroid 29·20, thermometer 80°, weather the same. 4 P.M.—Barometer 29·04, aneroid 29·20, thermometer 80°; heavy S.E. cyclone. In seven fathoms of water. Determined, on consultation with the chief officer, if there were no signs of clearing up before dark, to cut away the masts and anchor. 5 P.M.—Barometer rising. 6 P.M.—Barometer 29·28 (unreduced), aneroid 29·24. Sky breaking, and weather inclined to moderate; very high sea running. 8 P.M.—Wind moderating fast; barometer 29·36 (unreduced), aneroid 29·34. Let go the starboard anchor in six fathoms of water; vessel riding well. 10 P.M.—Moderating very fast; barometer 29·31 (reduced), aneroid 29·40, thermometer 80°; wind S.W. *16th.*—Day-light.—Sighted two light-vessels to the N. Noon.—Latitude, by observation, 21° 24′ N. 8 P.M.—The flashes of Saugor Light-House to the N.

N.B.—The observations of mercurial barometer are reduced for temperature, but the instrument has not been compared, neither has the aneroid.—W. G. W.

Extract from Log of the F. L. V. "Mermaid"—MR. E. WOODWARD, *Commander, Lower Gasper Station.*

Latitude 21° 27′ 40″, *Longitude* 88° 8′ 25.″

Date.	Hour.	Winds.	Barometer.*	Thermometer.	REMARKS.
October 15th.	4	N.E.	29·49	82	Blowing fresh, with thick cloudy weather and passing rain-squalls.
„	8	N.E.	29·49	80	Wind increasing, with thick cloudy weather and nasty cross sea. Native vessel at anchor abreast dismasted.
„ „	9	N.E. by E.	29·46	80	Wind and sea increasing with threatening appearance. Battened down fore and aft.
					9-30 A.M.—Parted the port chain cable. Let go the starboard anchor and coir cable.
„ „	10	E.N.E.	29·41	80	Wind increasing to a hurricane; vessel commenced to drive on the Gasper Sand. Let go the port anchor and coir cable, which parted immediately on being let go at 10 fathoms, abaft the splice.
„ „	10·30	E. by N.	29·39	80	Blowing a furious hurricane, vessel still driving, and the rollers making a clean breach over the vessel
„ „	11	E.	29·36	80	The same wind and weather. Sounded in six fathoms water; paid out on starboard coir cable to 150 fathoms, which brought the vessel up.
„ „	Noon	E. by S.	29·31	80	Wind and weather the same; vessel labouring heavily and shipping a great quantity of water.
„ „	1	E.S.E.	29·16	80	Wind and weather the same.
„ „	2	S.E. by E.	29·06	80	Ditto ditto.
„ „	3	S.E. by E.	29·04	80	Terrific cyclone and frightful sea. The lowest fall of the barometer.
„ „	4	S.E.	29·06	80	Same wind and weather; vessel shipping much water.
„ „	5	S.	29·16	80	Terrific squalls and lulls at intervals.
„ „	6	S.S.W.	29·16	80	Wind slightly moderating.
„ „	7	S.W.	29·19	80	Much less sea.
„ „	8	S.W.	29·30	80	Heavy gale and terrific squalls.
„ „	10	S.W.	29·44	80	Gale moderating and sky clearing; sighted Saugor Light. Bearing N. by W. by compass.
„ „	Midnight	S.W.	29·49	80	Blowing fresh with heavy squalls.

Report of the Commander F. L. V. "Planet," Upper Gasper Light.

Latitude 21° 32′ 40″ *N., Longitude* 88° 5′ *E.*

Date.	Hour.	Barometer (unreduced).	Wind.	REMARKS.
October 15th.	A.M.			
„ „	7	29·69	E.N.E.	Blowing fresh with an unsettled appearance. Hauled up 50 fathoms port coir cable and 80 fathoms starboard coir cable.
„ „	8	29·64	E.N.E.	Fresh, with occasional squalls and sea rising.
„ „	9	29·50	E. by N.	Freshening and very hard squalls; parted from 150 fathoms starboard, chain. Let go port coir; brought up with the V. W. Gasper buoy south; veered to 200 fathoms; battened down fore and aft.
„ „	10	29·40	E. by N.	Wind, sea, and squalls increasing.
„ „	11	29·30	E.	Ditto ditto.
„ „	12	29·30	E.	Ditto with heavy rain.
	P.M.			
„ „	1	29·28	E. by S.	Ditto ditto.
„ „	2	29·27	E.S.E.	Blowing very hard; heavy sea from S.E.; vessel taking it in over all.
„ „	3	29·25	E.S.E.	Ditto ditto.
„ „	4	29·24	S.E. by E.	Ditto ditto riding heavily.
„ „	4·30	29·22	S.E. by E.	Blowing a gale.
„ „	4·20	29·22	S.E.	Vessel driving. Let go starboard coir; veered to 80 fathoms. Still driving. Let go port chain cable, and veered away to 100 fathoms. Vessel coming up; blowing exceedingly hard.
„ „	5	29·30	S.E. by S.	A gale, much rain. Parted starboard coir cable.
„ „	6	29·40	S.	Ditto.
„ „	7	29·45	S.	Ditto.
„ „	8	29·65	S.W. by S.	Ditto.
„ „	8·30	29·65	S.W. by S.	Ditto. Took a cast of the lead, 5½ fathoms. Sighted Saugor Light (flash), bearing N. Moderating a little.
„ „	9	29·75	S.W.	Ditto ditto and sea abating.
„ „	10	29·75	S.W.	Wind and sea moderating.
„ „	11	29·75	S.W.	Ditto ditto.
„ „	12	29·75	S.W.	

* Reduced for temperature, but not corrected for instrumental errors.—W. G. W.

FRIDAY, 16TH OCTOBER 1874.

Date.	Hour.	Barometer (unreduced).	Wind.	REMARKS.
October 16th.	A.M.			
" "	1	29·75	S.W.	Very fresh with passing squalls.
" "	2-30	29·75	S.W.	The constellation of Orion visible.
" "	3	29·76	S.W.	Fresh with passing squalls.
" "	4	29·77	S.W.	Fresh with lightning from S. E. to W.
" "	5	29·79	S.W.	More moderate and cloudy. At daylight V. W. Gasper buoy S.E.¼E., 2 miles distant F. L. V. *Mermaid* S. by E., 3 miles. Commenced hauling up chain cable and getting another anchor over.

Extract from Log of the F. L. V. "Comet," MR. W. E. WILSON, Commander, Mutlah Station, Lat. 21° 6′ 20″ N., Long. 88° 48′ 10″ E.

WEDNESDAY, 14TH OCTOBER 1874.

Hour.	Barometer (unreduced).	Aneroid.	Thermometer.	Wind.	Weather.	REMARKS.
4	29·95	29·87	85	N.E.	Moderate	Daylight.—Vessel in position. Lowered station lantern; hoisted station flag.
8	30·02	29·94	85	E.N.E.	Ditto ditto.	Noon.—All hands cleaning iron work.
Noon	30·00	29·92	83	Ditto.	Strong breeze and ditto.	4 P.M.—Carried away coir spring just by the main hatch.
4	29·98	29·84	83	N.E.	Moderate gale	Sunset.—Vessel in position. Lowered down station flag. Hoisted station lantern. Fired the usual rockets.
8	29·93	29·85	83	E.N.E.	Moderate gale, much sea on.	
Midnight	29·90	29·83	83	Ditto.	Ditto ditto.	

THURSDAY, 15TH OCTOBER 1874.

4	29·78	29·70	83	E.N.E.	Fresh gale, much sea on.	Daylight.—Vessel in position. Lowered station lantern; hoisted station flag; battened down fore and aft and took the awning in.
8	29·85	29·77	83	Ditto.	Gale freshening, ditto.	A fresh gale blowing, much sea on; vessel labouring much.
Noon	29·80	29·72	83	S.E.	A very heavy gale.	Noon.—A very heavy gale blowing, vessel labouring very much; a very heavy sea on; one hundred fathoms of coir cable coiled down ready for veering.
4	29·79	29·71	83	S.	Ditto ditto.	5-30 P.M.—More moderate and less sea on, vessel riding more easily.
8	29·86	29·78	83	Ditto	More moderate, less sea.	Sunset.—Vessel in position; hauled down station flag. Hoisted station lantern. Fired the usual rockets.
Midnight	29·93	29·85	83	Ditto.	Hard gusts of wind at times, less sea on.	

FRIDAY, 16TH OCTOBER 1874.

4	29·89	29·81	83	S.	Squally with rain.	Daylight.—Vessel in position. Lowered station lantern; hoisted station flag.
8	29·99	29·91	84	Ditto.	Ditto ditto.	Noon.—Crew variously employed.
Noon	30·00	29·92	84	S.W.	Fresh and fine.	Sunset.—Vessel in position; hauled down station flag. Hoisted station lantern. Fired the usual rockets.
4	29·93	29·85	84	Ditto.	Ditto.	
8	30·00	29·92	84	S.W.	Moderate and fine.	
Midnight	30·04	29·96	83	Ditto.	Ditto ditto.	

Extract from the Log of the S. S. "Sir John Lawrence."

14th October.—A.M. commences with fine weather. 6 A.M. Dropped down to Garden Reach. 7 A.M. Pilot took charge and proceeded down the river. 8 A.M. Passed Atcheepore; 9-30, Hooghly Point; 10-30, Diamond Harbour. Noon. Barometer 29·60. Light airs with hot, sultry weather. P.M., moderate winds from N.E., with hot, sultry weather. 4 P.M. Passed Saugor. Heavy squalls from the eastward with rain. 4-15. Passed Gasper light-vessel. 5-15. Passed Lower Gasper. 6-15. Sighted Eastern Channel Light bearing S. 7 P.M. Passed a large vessel at anchor in the channel. Dark, gloomy weather, with a fresh breeze from the N.E. 7-30. Eastern Channel Light bearing E.S.E., seven miles; kept away across the eastern sea-reef; course W. by S. Heavy cross sea; vessel taking some heavy rolls. Kept away to the southward again. Midnight. Fresh winds and dark, gloomy weather with rain; barometer 29·58. Sounded in 15 fathoms, eased engines, and kept her head. Soundings in Balasore Bay.

15TH OCTOBER.

Hour.	Wind.	Barometer* (unreduced).	
1 A.M.	N.E.	29·50	Wind and sea increasing. Barometer falling. Dark, gloomy weather, and heavy bank to the S.E. Fresh gales from N.E.; vessel labouring heavily, shipping large quantities of water. Put head to wind with the engine going full speed, but found she would hardly steer.
2	N.E.	29·45	Heavy gales and cross seas; vessel labouring heavily, furled all awnings, sent all deck passengers below, and battened down the hatches, and laid her to on the port tack. Barometer still falling Sounded bottom at 15 fathoms, mud. Engines going ahead to keep her off the Palmyra shoals; shipping large quantities of water.
3	N.E.	29·40	
4	N.N.E.	29·20	Wind increasing, veering gradually to the northward.
5	.....	29·10	
6	N.	29·00	
7	N.W. by N.	29·02	Heavy cyclone with blinding rain; ship drifting bodily to the southward.
8	N.W.	29·00	
9	N.W.	29·00	
10	N.W. by W.	29·00	Cyclone raging fearfully.
11	W.N.W.	28·90	Ditto weather; barometer still falling, 28·90.
Noon	W. by N.	28·90	Noon.—Terrific cyclone with heavy sea; ship rolling heavily; three feet of water in engine-room; set all hands pumping. Engines stopped, as the steam could not be kept up, owing to the water in the bilges being too hot for the men to stand up in to fire up.
1 P.M.	W.	28·80	
1-30	.....	.....	Full force of the cyclone. Wind round to the westward; ship's head N.; barometer 28·75.
2	W. by S.	28·75	Heavy cyclone raging; washed away the gig, post cutter, and jolly-boat, and carried away the mizen top-mast by the upper band. Cleared away the wreck; found the lascars perfectly useless and quite exhausted, not having tasted food the whole day.
3	W.S.W.	28·90	Wind W., drifting to the eastward.
3-30	.....	.....	Heavy cyclone still raging. Barometer indicating a rise; remarked water muddy; sounded eight fathoms, supposed to be off False Point. Wind veered W.S.W. Gale abating and drifting bodily to the eastward.
4	S.W.	29·00	Barometer rising; sounded 15 fathoms; muddy water.
4-30	.....	.....	Decreasing to a fresh gale from S.W. with a high sea; vessel rolling heavily. All hands pumping and bailing out with buckets.
5	S.W.	29·20	
6	S.W.	29·30	
7	S.W.	29·30	
8	S.W.	29·30	
9	S.W.	29·34	Fresh winds from S.W.; got up steam and proceeded W.N.W. to make the land. Put new pump-valves into force-pump, and put deck passengers along with crew to pump water out of bilges.
10	S.W.	29·40	
11	S.W.	29·50	
12	S.W.	29·50	Midnight.—Moderate winds with passing clouds. Strong set to the S.E. No bottom at 50 fathoms. Engines stopped, steam down; as the steam could not be kept up, water in bilges being too hot. All hands pumping and bailing out water. Wind S.W.

16th October.—Moderate winds, variable and westerly, and high sea. Engines still stopped; set all sail. Set to the S.E. about 4 miles per hour. Daylight. Same weather. Noon. Latitude, by observation, 20° 4′ N. 1-30 P.M. Up steam and proceeded to N.W. to make False Point Light. 4 P.M. Sighted a vessel totally dismasted. Lowered the port life-boat and picked up seven men off the wreck. The vessel was called *Oma Pursad* of Balasore; waterlogged and dismasted.

Extract from the Log of the ship "Mistley Hall."

10th October.—2 A.M.—Anchored in 12 fathoms. Light-ship bearing N.N.W., distant two miles. 7 A.M.—Mr. Wells, pilot, came on board. 10 A.M.—Weighed; strong eddies; ship not steering, and dropping to the W. Anchored at noon; barometer 29·73. 4 P.M.—Light air; weighed on the flood; ship not steering and losing ground; anchored at 5-30 P.M. Midnight.—Calm.

11th October.—A.M.—Light variable airs and calms; barometer at noon 29·73. 4-30 P.M.—Light breeze, weighed, and made all sail, but cannot make any progress; anchored again. Midnight.—Calm, with lightning of a very peculiar description, resembling the flash of a gun.

12th October.—A.M.—Calm and cloudy. Dark, heavy appearance in the S.E., with thunder and lightning. 7 A.M.—Weighed and made sail. 9-30.—Calm; anchored again. Barometer at noon 29·77. P.M.—Calm throughout.

13th October.—A.M.—Calm; very fiery appearance at sunrise. Barometer at noon 29·73. P.M.—Calm and cloudy; stormy appearance at sunset.

14th October.—A.M.—Light breeze from N. and N.N.E.; weather very wild-looking at sunrise. 6 A.M.—Weighed and proceeded up the Eastern Channel; breeze increasing; *Grand Duchess* about two miles astern at noon. 2-30 P.M.—Anchored in Saugor Roads, light-house bearing E.¼N. Sunset.—Calm; every appearance of an approaching cyclone; lurid sky continuing long after sunset, and a peculiar moaning sound in the rigging; barometer 29·73.

15th October.—5 A.M.—Strong breeze, N.N.E., with squalls; barometer 29·73. Very stormy appearance at sunrise. Steam tug *Cyclone* came ahead, but immediately steamed away again and went up to Calcutta. 8 A.M.—Heavy squalls and torrents of rain; sent down royal

* A barometer which was supposed to be that from which these readings were taken was sent to me for comparison. I found its correction to the Calcutta standard to be +·005. This correction, however, would not be sufficient to make the above readings, which appear to be much too low, consistent with other data.—W. G. W.

yards; barometer 29·65. Got the tow rope round the ship outside the stern and passed in through the quarter pipe; the starboard end made fast to the bitts forward, and the port end lashed on the port chain at 105 fathoms with 15 stoppers. 10 A.M.—Wind E.N.E., blowing; barometer 29·59. Noon.—Strong gale and hard squalls; barometer 29·53. 1 P.M.—Wind E., hard gale with tremendous gusts and torrents of rain; let go second anchor with 30 fathoms of chain; barometer 29·43. 2 P.M.—Gale increasing; barometer 29·35. 3 P.M.—Wind E.S.E., a hurricane with tremendous gusts and high sea blowing over us from stem to stern; barometer 29·25. 3-30.—Ship driving; veered out both chains to the clinch, which brought her up. 4 P.M.—Hurricane increasing; wind S.E.; tremendous gusts; barometer 29·15. 5 P.M.—Wind S.S.E.; blowing very hard; ship riding very well; barometer 29·05—the lowest point reached. 6 P.M.—Terrific gusts; wind S; almost impossible to get along the decks; barometer 29·14. 7 P.M.—Gusts harder than ever; wind S. by W.; barometer 29·19. 8 P.M.—Wind S.S.W.; hurricane continuing in a most extraordinary manner; the ship fell off before the wind, and went over her anchors and remained in that position until midnight; barometer 29·34. 9 P.M.—Wind S.S.W., moderating; squalls still severe; barometer 29·41. 10 P.M.—Moderating fast; wind S.W., barometer 29·54. 11 P.M.—Wind S.W.; gale breaking fast; barometer 29·59. Midnight.—Moderate gale and cloudy; barometer 29·65.

16*th October*.—A.M.—Strong breeze, S.W., and cloudy. At daylight found the ship had driven about one mile; commenced to heave in the chains and spring; found the tow rope badly chafed in several places, and a few links of the port chain also chafed. At slack water hove up both anchors, and found them both clear; dropped into the channel and anchored. At 2 P.M.—Calm and clear. The crew of the brig *Juggonnautoo* came on board having been wrecked during the cyclone.

N.B.—On the 15th, during the height of the cyclone, the aneriod was constantly oscillating a tenth both ways. The aneriod from which the readings were taken has been compared with the Calcutta standard, reduced for temperature. The correction has been subtracted from the above readings.

Extract of a letter from MR. W. R. WILLIAMS, *Acting Master Pilot, to the Master Attendant.*

I HAVE the honor to report for your information the grounding of the schooner *Susan E. Vorhes* in my pilotage charge, outward bound, on the bank at Diamond Harbour, with the loss of her anchor and chain under the following circumstances:—

On the morning of the 15th instant I left Fulta with a strong breeze from N.E., weather looking very suspicious, and worked down to Diamond Harbour, where we anchored at 9·45 A.M. in 9½ fathoms water, 30 fathoms of chain to the windlass, and the Custom House bearing N.E. Weather looking very wild and threatening; barometer 30. 1 P.M.—Weather looking still more threatening and wind increasing, with every appearance of an approaching cyclone, excepting a low barometer. Let go the second anchor and paid out all the chain on board, 120 fathoms, giving her 30 fathoms before the windlass on the starboard side, and about 70 to the water on the port; barometer 29·95. 4 P.M.—Sent down the top-gallant yard and made all snug for bad weather; barometer 29·80; blowing very hard from E.N.E. 6. P.M.—Swung head to wind, which was now E.S.E., though it was not low water till 10 P.M. that night. 8. P.M.—Wind S.E. and blowing with increasing violence; barometer 29·76. 10. P.M.—Wind blowing in furious gusts with hurricane force; barometer 29·73. About this time started our anchors, or, as we afterwards ascertained, parted the port chain, which was the smallest, and commenced driving; when, fearing we should drift foul of the steamer *Sea Gull*, which had anchored close to us that evening, I gave orders, after consulting the Captain, to slip both chains, which were shackled together round the fore-mast, and hoist the fore top-mast stay-sail. This being done, we got her before the wind and put her on the bank a little above the Custom House at Diamond Harbour, where she now lies high and dry at low water, and quite upright, with her head S.E. and no appearance of having sustained any damage.

Extract from Government Meteorological register kept at False Point.

October 1874.	Hour.	Barometer reduced to 32°F.	Hygrometer.		Wind.		Rain.	Clouds.	Weather.
			Dry.	Wet.	Force.	Direction.			
14th	4	29·754	81	78	Calm	N.E.	.....	K	Fair.
,,	10	29·771	84	79	Strong	N.E.	.....	K	Dirty, t, l.
,,	16	29·696	82	78	,,	N.N.E.	.....	K	Dirty, t, l.
,,	22	29·702	79	76	,,	N.E.	0·90	N	Dirty, c.
15th	4	29·583	75	74	Gale	N.N.W.	.....	N	Ditto.
,,	10	29·594	76	74	,,	N.W.	.....	N	Ditto.
,,	16	29·577	78	75	Strong	W.	.....	N	Ditto.
,,	22	29·706	75	74	,,	W.	6·30	C	Fair, cloudy.
16th	4	29·716	75	74	,,	W.	.....	C	Ditto.
,,	10	29·804	80	76	Moderate	W.	.....	C	Ditto.
,,	16	29·702	84	79	Light	W.	.....	C	Fine, cloudy.
,,	22	29·787	81	77	,,	W.	.....	.....	Fine, b.

Extract from Government Meteorological register kept at Saugor Island Light-House.

October 1874.	Hour.	Barometer reduced to 32° F.	Hygrometer.		Wind.		Rain.	Cloud-covered sky.	Kinds of clouds.‡	Weather Initials.
			Dry.	Wet.	Velocity.	Direction.				
14	4	29·753	78·5	76·3	4·2	N.E.	.....	2	S.	b, w.
14	10	822	84·4	77·8	6·3	N.E.	.....	7	N. 4.	b, v.
14	16	726	77·2	75·8	16·3	N.E.	0·06	10	N. 4.	d, o, t.
14	22	747	77·5	75·8	7·6	N.E.	.....	10	N. 4.	d, o, u, 16.
15	4	634	77·2	76·9	12·2	N.E.	0·39	10	N. 4.	o, u.
15	10	621	79·7	78·0	.....	N.E.	1·48	10	N. 4.	o, q, r, scuds.
15	11·30	563	79·7	78·0	.....	N.E. to E.	.....	10	N. 6.	o, q. u, r ,,
15	12	514	80·3	78·7	33·8	E.N.E.	.....	10	N. 6.	d, o, q ,,
15	13	434	80·0	77·7	34·8	E.	.....	10	N. 8.	o, r, q ,,
15	14	343	77·4	77·0	4*	E.	.....	10	N. 8.	o, q, r ,,
15	15	264	78·8	77·4	4	E.S.E.	.....	10	N. 10.	o, q, r ,,
15	16	219	79·0	77·4	5	S.E.	1·35	10	N. 12.	o, q q, r, u, scuds.
15	17	174	.....	.....	5	S.E.† ?	.....	10	N. 12.	o, q q, r, u ,,
15	18	218	.....	.....	5	S.E.† ?	0·68	10	N. 12.	o, q q, r, u ,,
15	19	298	.....	.....	5	S.S.W.	.....	10	N. 18.	o, q q, r, u ,,
15	19·30	.....	.....	.....	6	S.S.W.	.....	10	N. 18.	o, q q, r, u ,,
15	20	384	.....	.....	6	S.S.W.	.....	10	N. 18.	o, q q, r, u ,,
15	21	464	.....	.....	5	S.W.	.....	10	N. 20.	o, q q, r, u ,,
15	22	540	81·1	78·0	5	S. ?	.....	10	N. 16.	o, q, r, ,,
15	23	578	.....	.....	4	S. ?	.....	10	N. 16.	o, q, r, u ,,
15	24	591	.....	.....	4	S. ?	.....	10	N. 16.	o, q, r, u ,,
16	2	597	.....	.....	3	S.W.	.....	10	N. 20.	o, q. ,,
16	3	609	.....	.....	3	S.W.	.....	10	N. 20.	o, u.
16	4	623	81·1	78·5	3	S.W.	1·44	10	N. 20.	d, o, u 8, lr.
16	5	638	.....	.....	.....	S.W.	.....	10	N. 2.	o.
16	10	756	84·0	80·7	.....	S.W.	.....	10	C. CK. 20 K.	v, scuds.
16	16	692	86·4	80·9	.....	S.W.	.....	3	CK. 28. N.	b, v.
16	22	783	81·3	77·7	.....	N.E.	.....	4	N. 20.	b, v, u 8 to 24.

* From this hour the force of the wind is estimated on the scale 0 to 6.
† The wind directions for these hours, as given by the *Mistley Hall* are, respectively, S.S.E. and S.
‡ The numbers after the clouds indicate the points from which they were moving, 8 being E., 16 S., and so on round for the 32 points of the compass.

Barometer readings at Contai, 15th October 1874.

Hour.	Aneroid Barometer readings.	Direction of wind.
7 A.M.	29·75	N. E.
8 A.M.	29·70	Ditto.
11 A.M.	29·50	Ditto.
1 P.M.	29·20	Ditto.
2 P.M.	29·10	Ditto.
4-30 P.M.	28·90	Ditto—Gusts furious.
4-35 P.M.	28·80	Ditto ditto.
5-7 P.M.	28 70	E.—Gusts furious.
5-8 P.M.	28·55	Ditto.
5-12 P.M.	28·45	Ditto.
5-30 P.M.	28·35	Ditto.
5-45 P.M.	28·10	Ditto.
5-55 P.M.	28·00	Ditto.
6-3 P.M.	28·00	Ditto.
6-18 P.M.	27·90	Ditto—Force of the wind something terrible.
6-27 P.M.	27·95	Ditto.
6-49 P.M.	28·10	Ditto.
7-10 P.M.	28·15	S, E.—Wind furious.
7-35 P.M.	28·35	Ditto.
8-10 P.M.	28·65	Ditto.
8-30 P.M.	28·80	S.—But gusts terrific.
8-35 P.M.	28·95	Ditto.
10 P.M.	29·30	S.—Wind falling.
10-30 P.M.	29·40	Ditto.
12-30 A.M. (16th October)	29·55	Dead calm.
7-15 A.M. (ditto)	29·70	Ditto.

Rainfall between 8 A.M., 15th, and 1 A.M., 16th, 9·050 inches.

Discussion.

On the 14th the *Coleroon* was at anchor on the Pilot station near the Eastern Channel Light-Vessel. In the early morning the weather was fine, with a light breeze from the N.E. Towards noon the sky became cloudy, and the wind freshened. In the afternoon there were squalls accompanied by heavy rain, and the wind increased gradually in force, and at 10 P.M. was blowing a moderate gale from N.E. by E. The barometer at 4 P.M. seems to have been somewhat higher than at the same hour of the previous day, but from this time it commenced to fall slowly. By 1 A.M. of the 15th the wind had increased to a fresh gale

from N.E. by E., and continued to blow from this point up to 5 A.M., when it veered to E.N.E. There was no apparent fall of the barometer from 3-30 A.M. to 6-30 A.M., the effect of the approaching storm being up to this time probably counteracted by the tendency of the pressure to increase from the A.M. minimum. At 7 A.M. the gale was fast increasing from the E.N.E., and the sea rising rapidly. The *Coleroon* now attempted to put to sea under reefed fore-sails and stay-sails. She appears, however, to have been driven from her position when at anchor, which was about five miles N.W.$\frac{1}{2}$N. from the Eastern Channel Light, almost right before the wind to westward; as at 8 A.M. the Lower Reef Buoy was observed bearing E.N.E. At 10 o'clock the wind had veered to the E. From this hour the barometer fell with wonderful rapidity,* and the vessel was entirely at the mercy of the wind and waves, drifting bodily to leeward. At 11-30 the reading of the barometer, corrected and reduced for temperature, appears as 28·95 and at noon as 27·88. These readings, if correct as regards time, indicate the extraordinary atmospheric gradient represented by a decrease of pressure of more than one inch of mercury in a distance between five and six miles. From noon the barometer fell comparatively slowly, and at 45 minutes past the clouds were clearing away and the sun faintly showing. At 1 P.M there was a lull, which lasted about 45 minutes. During this time the sun was visible. It was almost calm, with a very confused sea, and quantities of land birds were flying about the vessel. The lowest reading of the barometer, 27·58 inches of mercury, corrected and reduced for temperature, was recorded at 1-15 P.M., showing a depression of about 2·2 inches, or a removal of about $\frac{1}{14}$th of the normal weight of the atmosphere. The fearful violence with which the wind must have rushed into and up this atmospheric funnel can easily be imagined. At 1-30 P.M. the wind suddenly shifted to the S.W., but it was still nearly calm. At 1-45 P.M. the hurricane again burst on the vessel from W.S.W., and soon was blowing with greater fury than before the lull.

The position of the *Coleroon* at the time when the central calm was passing over her is unfortunately not exactly known. A sounding made at 1-30 in the middle of the lull, gave 18 fathoms; and from the way the vessel must have previously drifted before the wind, and taking into account the subsequent track of the centre of the storm over land, which is accurately known, I have little doubt that longitude 87° 43′ E., latitude 21° 2′ N., represents, within a mile or two, her position at 1-30 P.M. of the 15th. The position of the centre of the cyclone at 1 P.M. of the 15th may be stated, with as much accuracy as it is ever possible to arrive at in such cases, to have been longitude 87° 45′, latitude 21° N.

Taking the above as the position of the centre of the storm at 1 P.M., it will be interesting to note its bearing with reference to the direction of the wind at the several floating light-vessels and the neighbouring land stations. At the Mutlah light-ship, 70 miles distant, the wind was S.E. at noon, and probably had not veered much at 1 P.M. This would make the angle between the direction of the wind and the direction of the storm's centre a little more than 11 points, measuring round from the wind in the direction of the hands of a watch. At the Lower Gasper station, 34 miles distant, the wind was E.S.E., and the bearing of the centre almost exactly 9 points. At the Upper Gasper station, 38 miles distant, the wind was E. by S., and the bearing of the centre nearly 9$\frac{1}{2}$ points from the wind. At Saugor Island, 42 miles distant, the direction of the centre made an angle of exactly 10 points with the direction of the wind. At Contai, exactly north of the storm, and about 47 miles distant, the wind was N.E., giving an angle of 12 points. At Calcutta, about 100 miles distant, the wind was E.N.E., giving also an angle of about 12 points. False Point was at this time about 70 miles distant from the centre of the storm. The direction of the wind is not given, but it was N.W. at 10 o'clock and W. at 4 o'clock. If we assume the direction at 1 o'clock to have been W.N.W., the angle between the wind and the centre of the storm would be about 10$\frac{1}{2}$ points. The *Sir John Lawrence*, at this time probably somewhere

* See Plate I at the end.

on the Pilot Ridge, had the wind W. The exact position of the steamer is, however, unknown; but if the direction of the wind is given correctly for the time, the angle made with the direction of the centre could not have been less than 12 or 13 points. It is also quite probable that the wind had gone round to W. at False Point by 1 P.M., which would give an angle of 12½ points.*

The further progress of the storm over the *Coleroon* requires but little comment. The vessel, almost totally dismasted, was carried along by the south-westerly wind in the body of the storm across the Western Reef and up the Western Channel. The barometer rose much more slowly than it had fallen, and it was not until 5 P.M. that the hurricane commenced to moderate. The vessel anchored at 9-30 P.M. in six fathoms, with the flashes of Saugor Light-House bearing N.N.E.½E. At this time the wind from the S.W. had decreased to a moderate gale, and the sea had gone down considerably. The barometer stood at 29·52, corrected and reduced.

The *Coleroon* appears to have had a heavy increasing gale from a little before midnight of the 14th, lasting for about eight hours, up to 7-30 A.M. of the 15th, from which time for about 10 hours the wind blew with hurricane force. From 5-30 P.M. she had a decreasing gale, lasting for about four hours. Thus the extent of the gale in front must have been at least twice as great as the extent of the gale in the rear of the cyclone. If we take 10 miles an hour as the mean rate of motion of the storm over the Sandheads, this would give about 80 miles as the extent of the belt in front of the storm over which a heavy gale prevailed. Ten hours would give a longitudinal diameter of about 100 miles to the hurricane proper. But from this about 30 miles (the distance which the vessel was carried northwards in the body of the storm) must be subtracted, leaving a diameter of about 70 miles. The diameter of the belt in the rear of the hurricane over which a heavy gale extended would be only 40 miles. These numbers of course can only be taken as approximative. The same rate of progress would give for the diameter of the central calm about 7½ miles, supposing that the centre passed directly over the *Coleroon*.

The Pilot Brig *Cassandra* was five miles S.W. of the Eastern Channel Light-ship at 8 P.M. of the 14th, and was at that time tacking to the S.E. to make her station, with a strong breeze blowing from N.E. At midnight the barometer was falling rapidly, and there must have been all the indications of an approaching cyclone. The brig, however, seems to have continued on a south-easterly course, probably drifting considerably to westward when the wind got powerful, until she encountered the cyclone. She got into the central calm at 10 A.M. of the 15th, three hours earlier than the *Coleroon*, and hence about 26 miles further out to sea. The lull lasted for about an hour. The lowest reading of the barometer recorded was at 10 A.M., when the calm was first felt, 27·90, unreduced for temperature and uncorrected. There does not seem to have been any abrupt line of demarcation between the central calm and the hurricane outside. The wind first shifted to the westward and then gradually increased. About 15 minutes after the passage of the calm it was again blowing with hurricane force. By 3 P.M. the wind had moderated, but there was still a very high sea. The *Cassandra* was partially dismasted in the cyclone. She got back to the Eastern Channel station at 11 o'clock the next morning.

The Eastern Channel F. L. V. *Meteor*, parted her cable at 10 A.M. of the 15th, and was driven about 26 miles nearly fair up-channel. She experienced the eastern side of the cyclone, and was probably never as close as 20 miles to the centre. The lowest recorded barometric readings were at 2 P.M. and 4 P.M., 29·04, reduced for temperature, but uncorrected for instrumental error.

At the Lower Gasper station the F. L. V. *Mermaid* had a fresh breeze at 4 A.M. of the 15th from N.E., with thick, cloudy weather and passing rain squalls. The wind and sea increased rapidly up to 10 A.M, when it was beginning to blow a hurricane. At this hour the vessel parted from her anchors with the wind E.N.E., and commenced to drive on the Gasper

* The directions of the wind as given in this section are by compass. The variation is however only about 2° E.

Sands. She brought up again, however, to another anchor in six fathoms at 11 A.M., with the wind E., having drifted probably about three or four miles to the westward. The barometer was lowest at 3 P.M., 29·04, reduced for temperature but uncorrected, with the wind S.E. by E. Between this hour and 4 P.M., the centre of the cyclone was probably nearest to the *Mermaid*, about 24 miles distant. By 6 P.M., the wind from the S.S.W. commenced to moderate slightly, and from this hour until about 10 P.M., the *Mermaid* had a decreasing gale from S.W.

The F. L. V. *Planet*, at the Upper Gasper station, had a fresh breeze from E.N.E. at 7 A.M. of the 15th, and threatening weather. By 9 A.M., the wind had veered to E. by N., and there was a freshening breeze with hard squalls. The wind continued to veer steadily and increased in force up to 4-30 P.M., when it was blowing a full gale from S.E. by E. At this time the lowest reading of the barometer, 29·22, unreduced for temperature and uncorrected, was recorded. The wind continued as a heavy gale with torrents of rain throughout the evening, and veered further to S.W., at which point it commenced to moderate about 9 P.M., and after this hour the wind and sea rapidly decreased. During the passage of the cyclone the vessel drifted from her station, in a N.N.W. direction, about 1½ miles. The centre of the storm passed the *Planet* at a distance of about 28 statute miles.

The *Sir John Lawrence*, on her voyage from Calcutta to Chandbally, was in Balasore Bay at midnight of the 14th, with dark, gloomy weather and rain, and a fresh breeze from N.E. At 2 A.M. of the 15th the wind had increased to a heavy gale, still from N.E. A sounding about this time gave 15 fathoms, and the position of the vessel was supposed to be somewhere near the Palmyras Shoals. At 4 A.M. the wind had backed to N.N.E., and at 6 A.M. to N. From this time the wind blew with hurricane force, and the ship drifted bodily to the southward. The wind gradually backed to W. by 1 P.M. At 1-30 P.M. the lowest reading of the barometer, 28·75, uncorrected and unreduced for temperature, was recorded. The position the steamer at this time is unknown. From the fall of her barometer, the direction of the wind, and the position of the centre of the cyclone at the time, I should say that she was on the Pilot Ridge, in about latitude 20° 45′ N., longitude 87° 37′ E. The steamer must have drifted considerably to the southward, and then to the eastward, as the wind changed. At 1-30 P.M. she was probably not more than between 15 and 20 miles from the centre of the cyclone. The course of the steamer after this time is not by any means clear. She was at the mercy of the winds and currents, as it was impossible to work the engines. At 3-30 a sounding gave eight fathoms, and the vessel was supposed to be off False Point. Another sounding at 4 P.M. gave 15 fathoms, but at midnight there was no bottom at 50 fathoms, and the vessel was drifting to the south-eastward in a strong current of about four miles an hour. This current continued throughout the forenoon of the 16th, and at noon the steamer was in latitude 20° 4′ N., longitude unknown. I take it that the sounding of eight fathoms at 3-30 P.M. of the 15th was made not near False Point, but near to the spur of the Western Reef, where she had probably been driven by the S.W. wind, and that the steamer was afterwards carried in a south-easterly direction by the current from the night of the 15th, after the storm had passed. A rate of about between three and four miles an hour to the S.S.E. would account for her latitude at noon of the 16th.

The ship *Mistley Hall* was at anchor in Saugor Roads, W.½S. from the Light-House, and distant two or three miles, during the passage of the cyclone. The wind directions as observed by the master of this vessel correspond very nearly with those given in the meteorological register kept at the Light-House. There are, however, a few important differences. The wind-vane at the observatory was blown away before 5 P.M., and the wind directions at 5 P.M. and 6 P.M. were recorded both as S.E. The *Mistley Hall* gives the wind directions at these hours as S.S.E. and S. respectively, and I think that the ship's observations are in this case more accurate than those made at the observatory.

The indications of the approach of the cyclone at Saugor Island have already been discussed. The wind commenced to veer steadily round from about 10 A.M., when the storm's centre was about S. At noon the wind was E.N.E., the centre of the storm bearing S. by W.$\frac{1}{2}$W., about 60 miles distant. The angle between the wind and the direction of the centre at this time was 11$\frac{1}{2}$ points. The mean velocity of the wind between noon and 1 P.M., as observed by a Robinson's anemometer, was 34·8 miles an hour. This velocity corresponds to what is called a *fresh breeze*. It is to be observed, however, that the wind in a cyclone does not blow continuously but in gusts, which are succeeded by comparatively calm intervals, so that the mean velocity gives but little direct information regarding its force in the squalls. It is probable that the velocity in some of the squalls was at least double the mean velocity. The anemometer at the Light-House was not read after 1 o'clock, and the cups were blown away about 4 P.M. At 5 P.M. the barometer at Saugor Island was lowest, 29·174, reduced for temperature and corrected to the Calcutta standard. At the same hour, the lowest reading on board the *Mistley Hall*, 29·05 (aneroid, corrected), was also recorded. At this time, when the centre of the cyclone was probably nearest, the *Mistley Hall* gives the direction of the wind as S.S.E. The mean track of the storm's centre shortly after is known with some accuracy, as the central calm was felt at the villages of Rogunathpore and Egra. The former is W.S.W.$\frac{1}{2}$S. from Contai, 13$\frac{1}{2}$ miles distant, and the latter W. by N., 11 miles. A line drawn W. by S. from the light-house meets the mean track of the centre, which was then about N. by W. at the shortest distance, and this gives the probable position of centre of the vortex at 5 P.M. as latitude 21° 35′ N., longitude 87° 38′ E., distance from Saugor Light about 29 statute miles. The angle between the direction of the wind and the bearing of the storm's centre at this time hence appears to have been nine points. The direct distance between the above position and that at 1 P.M. is about 46 miles, giving a mean rate of progress of 11$\frac{1}{2}$ miles an hour. Shortly after 5 P.M. the centre of the storm reached the coast line, and from this until it passed Midnapore its course was nearly due N. Eleven miles N. of its position at 5 P.M. would place the centre of the storm due W. of Contai, about nine miles distant. However, the barometer was lowest at that place at 6-18 P.M.; and if we assume that the centre was nearest at this time, the rate of progress would be reduced to eight miles an hour. It will be seen afterwards that the mean rate of progress from Contai to Midnapore was not much greater than seven miles an hour, although from Midnapore to Burdwan the velocity increased considerably. Thus when it struck land, and about the place when its course commenced to re-curve, the motion of the storm was considerably retarded. The wind directions as given for Contai are not reconcileable with the barometric readings and the above course of the storm. When the barometer was lowest, and the position of the storm's centre probably due west, the direction of the wind is given as E. At Saugor Island at this time the wind was S. or S. by W., and the true mean direction at Contai was probably S. by E. It would seem, however, from the wind directions, as recorded, that not much approach to accuracy was intended; and I think they can only be regarded as giving a general idea of the way the wind veered. The shifting of the wind through three or fourth points in the squalls renders it a matter of considerable difficulty to form an accurate estimate of its true mean direction. In a closed-up house, and without a compass, the difficulty would be enormously increased. There is another point which is hard to reconcile with other data, about the wind observations at Contai. It is stated that at 12-30 A.M. of the 16th there was a dead calm, when the centre of the storm was not more than 45 miles distant. The above anomalies might possibly be explained by supposing that the first vortex, which passed Saugor Island, broke up, and that it was a different vortex which subsequently passed Midnapore. It is not by any means impossible that such may have been the case, but there does not appear to be any necessity for the supposition. The master of the *Mistley Hall* in Saugor Roads, about 20 miles from Contai, records a moderate gale at midnight, and the veering of the wind at Saugor

Island and at Calcutta exactly corresponds with the course of the storm indicated above.

A strong increasing gale seems to have prevailed at Saugor Island from about noon to 3 P.M., and from this hour to 9 P.M. a whole gale of wind. From 9 to 10 the gale was decreasing, but it continued to blow with considerable force for some hours afterwards. It is to be observed that a heavy gale was blowing for about two hours before 5 P.M., when the centre was nearest, but it lasted for about four hours afterwards with little diminution in violence. The comparatively long continuance of the force of the wind after the centre had passed is probably to be accounted for by the retardation of the storm's progress after it struck the coast-line, as above mentioned.

SECTION IV.

Progress of the Cyclone over Bengal.

The greater part of the data at my disposal for tracing the course of the storm over Bengal is derived from the reports of district officers, submitted to Government in reply to a circular calling for information in connection with the cyclone. Such portions of these reports as appear to throw any light on the meteorology of the storm and its progress are quoted in full. I have received also some information from private sources and derived assistance from letters published in the newspapers. Two of the Government meteorological observatories—Burdwan and Berhampore—were right on the path of the centre of the storm. From the latter, a valuable account has been received. The storm did not begin at Burdwan until late at night, and the clerk whose duty it is to read the instruments in the daytime* was unable to get to the Civil Surgeon's house, where the barometer is kept, after the cyclone had commenced. Unfortunately Dr. French was absent at the time on duty in the district, and no observations of the standard mercurial barometer were recorded during the passage of the vortex over Burdwan. A series of aneroid readings, taken from a medium sized instrument which was subsequently carefully compared with the standard barometer, are given in the sequel. For these and other data for the town of Burdwan and for the district, I am indebted to the Civil Surgeon, who took much trouble in collecting information.

The following highly interesting account of the weather at Pooree during the passage of the storm is taken from a report by Mr. H. W. Hill, Civil Surgeon of Pooree, to the Collector of the district:—

Prior to Wednesday, the 14th October, the wind had been from the sea during the day (E.N.E. to E.S.E.), and off the land at night (N. to N.N.E.); at early morning and up to 10 A.M. it was invariably N.E., coming in little puffs, but always finishing at the point from which it commenced. On Wednesday morning the wind was N.N.E. to N.E., coming in puffs, but with this difference—a puff came from N.N.E. and in a few seconds had gone N.E.; at 9 A.M. the first of the puffs came N. and finished at N.N.E.; this continued till noon. During the afternoon, till 5 P.M., the direction was N.N.W. and finished at N. At 6 P.M. puffs of wind came from N.W. to N.N.W., finishing as before, viz., two points more northerly. By 10 P.M. the wind had gone round to W.N.W., and during the night blew from S.W.; but towards morning (Thursday) again from W.N.W. At no time was there more than a moderate breeze. The wind was strongest from W.N.W. on Thursday morning; towards noon dying away calm. The barometric pressures† on the four days prior to the 14th are thus recorded:—

	10 A.M.	4 P.M.
10th	30·32	30·22
11th	30·38	30·22
12th	30·26	30·10
13th	30·24	30·16

Though no cyclone actually visited this part of Orissa on the 14th, yet one was visible at a distance in a northerly direction. Captain Garland of the ship *Canning*, lying at present in this roadstead, has kindly given me the following account:—"The cyclone was plainly in sight on Wednesday morning, rising slowly and moving to the northward. At noon, its appearance was as if the sky had been painted black, extending on the horizon about four points, and reaching an altitude of about eight degrees in the form of a segment of a circle. Its edges clearly defined, and clouds (cumuli) floating across from the N.E. The extreme right bore S. by E., and left S.E. by E. The sea, which had been S., had gradually worked round to S.E. (I should rather say there were two seas—one from S., the old one, and the other from S.E.) During the afternoon, the black mass could plainly be seen gradually altering its bearings. At 6 P.M. it bore E.S.E. and E.N.E., and had attained an altitude of 12° or 15°. The sea, too, was rolling on heavily from E. to E.S.E. On Thursday morning, the mass was bearing N.E. by E. and N. by W., to N.N.W., with an

* Observations taken twice a day, at 10 A.M. and 4 P.M.

† Probably aneroid readings. The instrument evidently reads much too high.—W. G. W.

altitude of at least 25°. The sea was now much confused—in short, going nowhere. Facing the wind, the middle of the mass was usually ten points to the right." Captain Garland has given me the following barometric variations as observed on board the *Canning* :—

Wednesday,	10 A.M.	...	...	...	...	...	29·95
„	4 P.M.	...	...	...	...	...	29·85
„	6 „	...	...	...	...	...	29·85
„	7 „	...	...	...	...	...	29·87
„	10 „	...	...	...	...	...	29·92
Thursday,	10 A.M.	...	...	...	...	...	29·92
„	4 P.M.	...	...	...	...	...	29·83
„	10 „	...	...	...	...	...	29·91
Friday,	10 A.M.	...	...	...	...	...	29·95
„	4 P.M.	...	...	...	...	...	29·90

The rapidity with which the wind backed round from N.E. to W. at Pooree is remarkable. If the track of the cyclone up the Bay, as I have given it, be approximately correct, the centre of the storm could not have been due E. of Pooree much before midnight of the 14th, and the wind at that place had gone round to W.N.W. at 10 P.M., and that time it must have been blowing almost directly towards the centre. Pooree was about 140 miles distant from the storm when its centre was due E. The backing of the wind at Cuttack about 124 miles distant from the nearest point of the track of the storm's centre was very similar, It was N. at 10 P.M. of the 14th, and went round to W. by 4 A.M. of the 15th, at which point it continued the whole day.

Captain Garland's account of the atmospheric meteor visible from Pooree roadstead on Wednesday and Thursday morning is curious, but not altogether intelligible on the supposition that the mass of clouds which he was looking at was on the outer circumference of the gale round the vortex which passed over the Sandheads on the 15th. At 6 P.M. of the 14th the bearing of the centre of the cyclone from Pooree was about E. by S.½S., distance 160 miles, and the bearing of the centre of the black patch, observed by Captain Garland, was E. At this hour, then, the bearings would nearly correspond, and the difference might be accounted for by saying that the atmospheric disturbance round the storm extended further to the N. than to the S. However, the bearings of the black mass at noon of the 14th and on the morning of the 15th are not so easily reconcilable with the course of the storm. The probabilities are, I think, that the phenomenon was only indirectly connected with the cyclone, and that it was a result of the general progress of the whole atmospheric disturbance from the S.E. of Pooree to the N.E.

The following extract of a letter from Mr. S. E. J. Clarke, Honorary Magistrate of Chandballi, to the Collector of Balasore, contains some interesting remarks on the tidal wave, and also regarding the suddenness with which the cyclone burst over the Sandheads :—

In continuation of my letter of the 16th instant, I have the honor to submit such further information relating to the cyclone of the 15th instant as I have been able to collect. I may mention that on Thursday the tide rose at Chandballi to a height only exceeded by a high flood. The river-water, however, at this place continued sweet. The tide on the 15th instant was at least 18 inches higher than on the 14th or 16th. I cannot tell the exact height, as the gauge here is only for 12 feet above zero, and it was submerged entirely. The tide was accelerated by about 1½ hours.

Since the storm the steam ships *Bombay*, *Curlew*, and *Sir John Lawrence*, have arrived. The latter vessel left Calcutta on Wednesday morning, and did not notice anything peculiar in the weather till the Eastern Channel Floating Light was reached. Passing down the Eastern Channel some vessels were noticed riding with their heads E., and yet the swell was S.E. The weather looked threatening, but the barometer was high. I cannot help thinking that the heavy set from the E., the high barometer, and the cross swell ought to have warned the captain and pilot of what was approaching. Unlike most cyclones, however, this storm, did undoubtedly burst over the Sandheads suddenly. The *Sir John Lawrence* experienced no bad weather until about half way between the Eastern Channel floating light and the Kanaka buoy. About midnight the ship experienced a gale, and was kept ahead to wind, with the engines going full-power. The gale gradually increased, and the ship's head was kept to the wind, yet she shoaled at one time into 7 or 8 fathoms, and was only saved by a shift of the wind. When the gale finally broke she was abreast of Ganjam, say 120 miles off her course. This is noteworthy, as she was kept going full-power against the storm all

the time nearly. Returning she picked up the crew of three native sloops. She reached Chandballi on Sunday about 3 P.M., having lost her mizen topmast, smashed her wheel, lost all her boats but one, and one native passenger from exhaustion. Before making the Dhamra she passed through an immense number of buffaloes and cows, all dead and floating out to sea with the tide.

Balasore District.

The following account of the cyclone in the Balasore district is taken from the report of the Collector, Mr. T. Norman.

The barometric readings made at Balasore on the day of the cyclone and the preceding and following days unreduced for temperature, but accompanied by thermometric readings, are as follows :—

Date.	At 7 A.M.		At noon.		At 4 P.M.	
	Barometer.*	Thermometer.	Barometer.	Thermometer.	Barometer.	Thermometer.
14th October 1874	29·64	84	29·68	84	29·62	85
15th „ „	29·53	80	29·48	80	29·23	79
16th „ „	29·54	83	29·63	83	29·49	84½

Along the coast-line, the western limit of the cyclone of the 15th instant, which entered the country from the Bay of Bengal, was coincident with longitude 87° 15′, and almost precisely conterminous with the western boundary line of the Baliapal police station jurisdiction. Accordingly, the only portion of the district which fell within the track of the cyclone has been the northernmost police station jurisdictions of Baliapal and Jellasore, excluding the pergunnah of Futiabad on the west bank of the Sooburnrekha, which forms the north-western corner of the district.

A gale, with moderate rain, occurred in the south of the district on the 15th instant. The intensity of the gale continued six hours, viz., from 3 A.M. to 9 A.M The direction of the wind was N. and N. by W. The strength of the gale was only moderate, and no damage was done. It is best described by Mr. Clarke, writing from Chandballi on the 16th instant:—

"For a week previous to Wednesday, the 14th October, Chandbali was visited at about noon by very heavy rain-squalls from the south-east. There was this peculiarity about these squalls, that one day the shower would pass over the station, whilst the next it would pass away along the south side. The squalls were marked by heavy and continuous thunder peals. During all this time the barometer was very high and the heat intense.

"On Wednesday there was a marked change in the weather, the clould-bank on the S.E. being steadily on that quarter, while the day, as it wore on, became overcast with dull, leaden clouds, and the wind shifted in gusts from E.S.E. to E., and by 4 P.M., to N.E. Here it blew fiercely for awhile, but at sunset it was nearly calm. At this time the appearance of the sky to the E. and S.E. was threatening in the extreme. Overhead a few light clouds floated swiftly to the S.W., while all the eastern horizon was laden with a dense slate-coloured mass of clouds, against which a few cirro-cumuli showed in ghastly grey whiteness.

"During the day there had been some short fierce showers from the E., but at sunset there was no immediate appearance of rain. From 7 P.M. the wind increased fitfully, and at 9 P.M. the gale was fast increasing. At 2 A.M. the wind shifted round to the N.N.E., and blew in heavy gusts with rain, driving in misty clouds along the ground. From 4 A.M. of the 15th to 10 A.M. the wind blew from the N. and N. by W. The gale was at its height from 3 A.M. to 9 A.M. After this, although the rain was still heavy and the wind very high, there were longer intervals between the squalls, and at noon it was plain the storm would soon break. At 4 P.M. the rain ceased, and the weather broke in the N.W. and S. to S.E.; but along the E. and N.E. sky there was a remarkable bank of leaden-coloured cloud and signs of rain falling. The wind gradually lessened to what the sailors would call a 6 or 8 knot breeze, and finally died away about daylight to-day (16th), to be succeeded by a light air from the S.

"No damage was done in this neighbourhood, except a few walls being undermined by the heavy driving rain. No trees were overturned. No houses unroofed. The storm therefore was not heavy. I have word from Kymah (12 miles W.), and there it was more of a heavy rain-storm than anything else. At Jajepore it was simply bad weather. All the appearances indicate, however, that a heavy storm of a cyclonic character has passed up the

* It is not stated whether these readings were taken from an aneroid or mercurial barometer. If from the former, they should not be reduced for temperature. The instrument evidently reads much too low.—W. G. W.

Bay of Bengal, and that it affected an unusually large tract, as far as breadth is concerned. It was at this place unaccompanied by thunder, whilst at Jajepore there were few light peals."

In the centre of the district the force of the wind was greater. Nevertheless the centre also was clearly beyond the track of the cyclone, and suffered no damage, except of a trifling character. The following are reliable observations taken of the force and direction of the wind in Balasore town during the 14th, 15th, and 16th of the current month.

14th October.—Morning, wind N.W. to S.E., light; noon, light wind, cloudy. 2 P.M. S.E. and E.N.E., light wind, threatening weather.

15th October.—Morning, wind E.N.E., strong breeze, veering to N., heavy rain; noon, wind N.W., a strong gale with heavy rain. At 4 P.M., wind N.W.

16th October.—Morning, wind S.W., light and cloudy, variable to W.; noon, S. E., light and variable to N.W. and S.W. At 4 P.M., light.

On the 15th instant fierce gusts prevailed from 7 A.M. to 9 A.M. At 9 A.M. a strong gale set in, at first with occasional partial lulls, but blowing without interruption as it reached its height, which it did at 3 P.M. After 4 P.M. it moderated by degrees up to 8 P.M., when the gale was at an end.

As already mentioned, the only portion of the district falling within the direct track of the cyclone was the two northernmost police station jurisdictions of Baliapal and Jellasore, excepting the Futiabad pergunnah on the west of the Sooburnrekha, where trees and houses have suffered damage, but not of a severe character. Baliapal has a population of 69,416 souls, and Jellasore a population of 45,723. Here the ravages of the storm have been almost indescribably disastrous. It is unanimously described as having raged in its intensity from noon till midnight. The Deputy Collector, who was deputed to visit the locality, reports that, to the best of his judgment, the number of deaths from falling walls and roofs has not fallen short of 200. The police have already officially reported 69. The Deputy Collector reports that about half the cattle have been destroyed and three-quarters of the houses have been totally demolished. The stench that met him everywhere from putrefying carcasses was sickening, and none of the villages visited by him contained a single tank of wholesome drinking water, all being polluted with decomposing animal and vegetable matter. The Deputy Collector describes the banks of the Sooburnrekha as covered with the carcasses of cattle, and his account in this respect is borne out by the reports of passing steamers, which observed large numbers of dead cattle and a smaller number of human corpses floating in the sea off the coast. Of one portion of his journey the Deputy Collector writes:—"All the way from Baliapal to Bhograi the country presented a scene of universal desolation. Almost every house was destroyed, and scarcely a tree stood straight or erect. The paths were blocked up by fallen trees. The ground was strewn with putrescent vegetable and animal matter, and these and the tanks and pools when disturbed sent forth a stench which was insupportable. The Bhograi outpost was a complete wreck, and the only building standing in the village was the pucca Siva temple of the zemindar, Gopendro Mohun Chowdhry."

It is singular how well marked has been the western limit (of which alone I have any information) of the recent cyclone, as evidenced by the fact that outside the limits indicated above, not a single death is known to have been caused by it except one, which was only traceable, in a remote degree, to the agency of the cyclone.

Mr. Clarke's account of the gale experienced at Chandbally is remarkable. It appears that the gale was strongest from N., and considerably earlier than the nearest approach of the centre of the cyclone. The centre of the storm was nearest about noon, bearing a little north of east from Chandbally, and about 63 miles distant. The direction of the wind after 10 A.M., when it was N. by W., is not stated. It had probably gone round considerably to the westward by noon. It will be seen further on that the westerly wind, after the passage of the storm's centre at different places on land, was not nearly so powerful as the northerly current beforehand, and that the violence of the wind from this quarter very rapidly decreased.

The most remarkable feature of the cyclone on its western side, was, as Mr. Norman points out, the abruptness of the line of demarcation between the violent and destructive part of the hurricane, and a moderate gale outside. This phenomenon was also strongly marked in the passage of the storm through the Midnapore district, as will be seen further on. Mr. Norman gives the western limit of the destructive part of the hurricane as coincident with longitude 87° 15', where it entered land from the Bay of Bengal. This would give a radius of about 24 miles to the violent part of the hurricane on the western side, and it is very remarkable that it was near the western limits of the belt traced out by the above radius as the storm advanced that there was the greatest destruction of life and property.

Midnapore District.

The following account of the storm at Midnapore is taken from a letter from Mr. H. L. Harrison, Collector of the district, to the Commissioner of the Burdwan Division, written a few days after the storm and before detailed information had been received from other places:—

As I have already informed you demi-officially, I regret to have to report that the Midnapore district was visited on the night of Thursday, the 15th October, by a cyclone far surpassing in intensity that of 1864.

Description of the storm.—Slight rain began to fall about 4 A.M. on the morning of the 15th, accompanied by a light wind from the N.E. by E., evidently an under-current only, as the clouds visible above, through the lower clouds, were almost stationary. This wind continued to increase throughout the day, and by 4 P.M. would be accurately described as a high wind from N.E. by N., accompanied by copious rain; it was still short of a gale. By 6 P.M. it was blowing a gale almost from due N. and raining very heavily; in another hour it was evident that we were in for a cyclone, and by 9 P.M. the wind was sweeping by in furious gusts, accompanied by torrents of rain. Still the force of the storm continued to increase, changing its direction very slowly from N. to N.N.W. At the time of its maximum, which I should fix at 12 P M., it was blowing at an angle of 15 to 20 degrees from the N., and all the large trees have fallen to the S. by S. E. After 1½ A.M. the wind veered uninterruptedly towards the W, and at the same time diminished rapidly in intensity; and by daybreak on the 16th, the rain had ceased and a moderately high wind was blowing from the W. or W. by slightly S. During the 24 hours over 10 inches of rain fell.

Injury to the town.—Morning showed but too clearly that the station and town had been wrecked; few, if any, kutcha buildings that were not protected by large blocks of pucca buildings had escaped. The force and copiousness of the rain had caused the mud walls to melt away, while the wind lifting the thatched roof had completed the ruin. Even pucca houses could not keep out the rain, which forced an ingress through broken windows, through the panels of shutters, and between the fastenings of doors. Skylights were broken, and all appurtenances, such as cutcha verandahs, projecting bath-rooms and sheds of every description, were stripped off.

Loss of life.—The loss of life in the town was very lamentable, caused by falling trees, falling houses, and in some cases by children and even women being blown away, and life beaten out of them by the pitiless fury of the elements; others were blown into tanks or down wells and drowned. The loss of life was much increased by the khal or brook which runs through the centre of the town. It only drains two or three square miles of country, and in the hot weather is perfectly dry; in the rains it is usually a brook about six inches deep and two yards across, swelling, of course, immediately after rain.

The intensity of the rainfall during the few hours that the cyclone lasted, was such that this brook became converted into a considerable stream, bearing down the broken branches that the wind tore away from the trees on its banks; these in turn choked up the bridges through the town, and the water thus dammed up found no escape except by passing down the side-lands and bearing against the houses on its banks. The force of the current, superadded to the violence of the wind, swept all before it, and the wreck at two of these bridges surpasses that in any other part of the town. In some cases all traces of houses have disappeared. The loss of life here was greater than anywhere else; many of the occupants of these houses were crushed or half-crushed and carried into the khal, and bodies continued to be found in it up to the third day. In all, the loss of life in the town amounts up to about 100 souls, and I fear in the whole district it will far exceed 1,000.

Destruction of trees.—Were it not dwarfed by comparison with the pitiable loss of life and property, the destruction of trees alone would be most disheartening. Trees cannot find deep root in the laterite soil; and magnificient mangoes, peepuls, and other trees with their roots spreading horizontally over many yards of ground have been torn up by the roots and dashed to the ground. All the labors of years in arboriculture have been rendered futile in a single night. Probably one-third of the trees in the station have been blown down, and those whose roots have stood have had their best branches stripped and rent off. It is no exaggeration to say that on the morning of the 16th the face of nature seemed changed.

Central Jail.—The violence of the gale at its height proved too much for the outer wall of the central jail which faces that direction. Two breaches of about 50 yards each have been made in it. The upper 12 feet or so have been blown down, and it stands about 4 feet high only.

It is evident, therefore, from the data already known, that the storm fell upon this district from the S.E., the vortex travelling in a curvilinear orbit, which about the latitude of Midnapore, became due N. and S., and beyond Midnapore, turned to the N.E. Bankoora,

therefore, will probably have escaped, as will Raneegunge; but unless the cyclone had by that time worn itself out, it will have passed over the Burdwan district, and not improbably over the town itself."

The following extracts are taken from Mr. Harrison's final report, and its enclosures, to the Commissioner. I only give the parts referring to the meteorology of the storm, and those containing summaries of the loss of human life and cattle:—

Extract from MR. HARRISON'S *final report.*

I HAVE the honor to submit a further and final report on the effects of the cyclone of the 15th and 16th October in the Midnapore district.

Mr. Macaulay was deputed under demi-official orders from Government to visit the places most affected in the south of the district. I also deputed Baboo Mohanund Gooptoo, Deputy Magistrate, to visit the north of the district. Both of these officers have submitted reports, which I enclose in original, as also that of the District Superintendent of Police. Accompanying this latter officer's report is a *précis* showing the injury done, thana by thana. I annex it also, as the details may be useful to the Meteorological Reporter.

The returns of mortality and the estimated destruction of cattle have now been collected from all quarters, and the former, as I feared, far exceeds 2,000. As the District Superintendent points out, it is probable that the actual mortality is in excess of that which has been traced out. Beginning with the west, the mortality is reported as follows:—

Jungle mehals.—Beenpore ... / Jhargram ... / Gopeebullubpore ... } *Nil;* only a high wind extended to these thanas.

		Loss of human life.	Estimated loss of cattle.
West of the vortex ...	Gurbetta	196	1,000
	Salbunny	83	285
	Keshpore	693	3,000
	Midnapore	396	2,100
	Narainghur	187	1,491
	Dantoon	341	2,344
		1896	
Intersected by vortex ...	Chundercona...	24	106
	Debra	72	219
	Subung	147	300
	Pataspore	62	No estimate.
	Egra	92	1,750
	Rogoonathpore	212	1,700
		609	
East of vortex ...	Ghattal	44	No estimate.
	Dosspore	49	270
	Panchkoora	52	172
	Bhugwanpore	133	329
	Contai	175	2,123
		453	
Further east, only partially within destructive belt.	Tumlook	20	70
	Muslundore	4	27
	Nundigram	67	No estimate.
	Sootahatta	...	...
	Kedgiri	...	279
		91	
	Total of 25 thanas ...	3,049	17,565

These returns indicate one result, which is contrary to what would have been expected but which is thoroughly confirmed by the general experience in this district, viz., that instead of the violence of the storm being greatest at its vortex, and next to that east of the vortex, and lastly west of it, the power of the wind was greater west of the vortex, and next at the vortex, and least east of it. I do not know whether the surmise is scientifically possible, but the indications in this district lead to the inference that instead of the wind describing a circle, or being nearly circular, it described a curve, more like that of a six (6),* the greatest power being at the first bend of the 6, opposite the vortex.

* As the figure is written, not as it is printed.—W. G. W.

Were the form of the cyclone circular, to places on the line of the centre the wind should begin at right angles to the path of the storm, or in this case from the E.; and to places east of the vortex the wind should begin from the S.E., while only to places lying west of the centre should it begin from the N.E. In the present instance, however, all accounts agree in representing the wind as beginning from the N.E., which the 6 shape would account for.

Again, it appears that the west side of the cyclone was far more clearly definable than the east side. In the one case, when one gets beyond the destructive belt, one soon loses all trace of the storm, and the damage is *nil;* but to the east side, no such easily definable line can be traced. A very high wind seems to have extended even beyond Calcutta, which cannot have been less than 55 to 60 miles from the vortex at its nearest point.

It would thus seem as if the wind swept down from the N.E. in almost a straight line, at a constantly increasing rate, till it reached the level of the vortex, when it was at its maximum. After that, the centrifugal force seems to have been counteracted by the centripetal (if it is legitimate to speak of such a force in a cyclone), and the result to have been a diminution of violence and a bulging out of the wind towards the E., due to centrifugal force.

Whatever these theories may be worth, the fact remains that the heavy mortality and the maximum damage occurred with complete uniformity west of the vortex. Salbunny thana may seem to be an exception; but if the map is examined, it will be found that this thana lies west of Keshpore, and was very near the edge of the destructive belt: hence, looking to the small portion of it reached, and the position of that portion, the damage done is far from light.

As regards the rate of progression of the storm, it appears to have been at its maximum at Contai at about 8-30* P.M., when the wind was veering round from S.E. to S. The Egra report, as regards time, is evidently wrong, but the vortex is stated to have reached Pataspore about 10, or say the centre of the vortex at 10¼. At Debra the lull is stated to have occurred about 2 A.M., which can only be approximate, as the police had no reliable clocks, and I suspect 1 A.M., judging from the analogy of Midnapore, would be nearer the mark. This also agrees with the reports from the places further north. Hence the storm travelled from Contai to Debra, which is about 50 miles, in 4½ hours, showing a rate slightly in excess of 10 miles an hour.

Extract from the report of MR. H. W. BAMBER, *District Superintendent of Police.*

IN accordance with the instructions conveyed in Government circular dated 28th ultimo, I have the honor to annex a brief account of the cyclone of the 15th ultimo, as epitomized from the police reports. Those previously received were vague on many important points, so I obtained subsequently further information. I fear, however, that, as the police were not careful to note the precise time of the cyclone and the variations in the wind and other atmospherical observations, the information I have obtained from them is somewhat inconsistent, and thus a clear statement of the progress of the cyclone, as it reached station after station, cannot be satisfactorily traced. I observed that between longitude 87° 22′ and 88° east is the portion of the district that was influenced by its force. Some of the police stations have suffered unaccountably less severely than others, although within the same belt.

I beg to show, per margin, the names of stations visited by the cyclone, together with the number of deaths reported to, and by, the police. In the body of the narrative they have been shown under the various headings by which they are supposed to have met their death; of course drowning and being crushed to death are the two main causes. The mortality as shown appears to be large; and yet I can confidently say that I believe a large number of deaths have not come to the knowledge of the police; such as those who have lost their lives in boats. And those who live any distance from the police have been sufficiently burdened with their homes being destroyed to proceed any long journey to lay a formal information of this nature. The marginal figures appear to strike one as being very disproportionate when comparing one station with another, and yet it is unreasonable to suppose that such deaths have been concealed in a wholesale manner.

Head-quarters' sub-district.		
Midnapore	...	396
Debra	...	72
Keshpore	...	693
Dantoon	...	341
Narainghur	...	187
Salbunny	...	83
Sabhang	...	147
Daspore	...	49
Total	...	1,968

Gurbetta sub-division		
Gurbetta	...	196
Chundrakona	...	24
Ghatal	...	44
Total	...	264

Tumlook sub-division.		
Tumlook	...	20
Panchkura	...	52
Maslandpore	...	4
Nundigram	...	67
Sutahata	...	0
Total	...	143

Contai sub-division.		
Contai	...	175
Kedgiri	...	0
Bhugwanpore	...	133
Rughoonathpore	...	212
Egra	...	92
Pataspore	...	162
Total	...	674
Grand Total	...	3,040

* The barometer at Contai was lowest at 6-18 P.M., and it is probable, as pointed out in SECTION III, that the centre of the storm was nearest about 6-30 P.M., or two hours earlier than the time here given by Mr. Harrison.—W. G. W.

Extract from Narrative of the cyclone of the 15th October 1874 in the Midnapore District, as gathered from the Police Reports.

HEAD-QUARTERS' SUB-DISTRICT.

Midnapore.—The police report that before daybreak of the 15th the weather became unsettled, with rain and gusts of wind, and thus it continued until 4 P.M. When the cyclone commenced, wind was blowing from N.E. At about 9 P.M. it veered to the N. when it blew with great fury. About 11 P.M. the wind was from the N.E. and continued in that quarter till 3 A.M., when the wind went to the W. and the storm ceased. There was no perceptible lull during the storm. The storm was at its height between 11 P.M. and 2 A.M., during which period the greatest destruction occurred. The heavy rain appears to have weakened the mud walls of houses and led to their destruction.

Debrah.—The police report unsettled weather, and corroborate the statement made by the Midnapore officer until 2 A.M., when they report a sudden lull of half an hour during the cyclone, after which it raged with its greatest fury from the W. between 2-30 and 4 A.M., which levelled to the ground both houses and trees.

Keshpore.—The police report on 15th, early, a strong N.E. wind blew. About mid-day rain fell. From 4 to 9 P.M. the wind and rain increased. At 10 P.M. the cyclone commenced—wind in the same quarter—and lasted till 3 A.M., when there was a partial lull, after which the storm raged from the N.W. with greater force than before, and lasted for about 1½ hours, after which the storm cleared away.

Dantoon.—The police report that before daylight of the 15th it rained and blew from the N. and continued so till 3 P.M., when the cyclone commenced, blowing still from N. and lasted till 7 P.M., when the wind veered to the N.W. It decreased at 11 P.M., and the storm was gone by 2 A.M. The storm was at its height about 7 P.M.

Narainghur.—The police report rain, with wind from E. before daybreak of the 15th. About 10 A.M. the rain and wind ceased. Again about noon the wind increased, with rain, until 8 P.M., when the cyclone commenced. Wind blew from N. After an hour it veered to N.W. after which it constantly changed from E., N., and W.; its violence was chiefly from N.W. There was no lull during the storm, which ceased at 3 A.M. The cyclone was at its height from 11 P.M. to 1 A.M., at which time serious destruction was caused.

Salbunny.—The police report that during the entire day of the 15th there was constant rain with high wind. In the evening a strong northerly wind, with rain, which increased in force each hour, until at 10 P.M. the cyclone raged. At midnight it was at its height, the wind blowing from the N.W. when serious damage to house property occurred. At 2 A.M. it veered to the W. and at 4 A.M. the storm had passed away. There had been no lull during the cyclone. The heavy rain caused a tremendous flood, which inundated the entire country, and led to some loss of life.

Beenpore.—No cyclone; rain and some wind between midday and midnight of the 15th.

Gopeebullubpore.—No cyclone; rain and some wind between midnight of the 14th and the same time of the 15th; no damage caused to buildings or crops. The Nyagram outpost building has had the roof partially injured from high wind and rain that prevailed there.

Jhargram.—No cyclone; rain and some wind between midday and midnight of the 15th. The Ghutea outpost police report but slight rain.

Sabhang.—The weather had been unsettled with rain and wind all the 14th and part of the 15th. After about midday the weather partly cleared. At 5 P.M. the cyclone began to rage, wind being N.E. It then frequently, till midnight, varied its direction. After midnight it went to S.W. and at 2 A.M. there was a perfect lull, and then another blow, which lasted till 3 A.M., with heavy rain, after which the storm cleared off. It appears that the Haldi river, from its swollen state, filled its tributaries—the Kaliaghye and Kapalsee khalls—which burst their embankments, flooded the country, and destroyed a large number of new houses.

Daspore.—There had been unsettled weather with rain and wind all the 14th and portion of the 15th until 9 P.M., when the cyclone began, with wind from the N.E. The wind constantly changed until 2 A.M., when there was a partial lull; after which it again raged from S.W. with its greatest violence, destroying houses and uprooting trees. The storm broke at 5 A.M.

GURBETTA SUB-DIVISION.

Gurbetta.—The police report that there was rain and an easterly wind during the day of the 15th. After evening the wind changed to N.E, and from 11 P.M. to 3 A.M. the cyclone raged, wind being at the time from the N., between which hours much destruction was caused. At 4 A.M. the wind was westerly, and the storm broke. There was no perceptible lull during the cyclone. The storm was at its height about midnight.

Chundrakona.—The police report that there was heavy rain during the day of the 15th with a strong N.E. wind. From 9 P.M. to 2 A.M. the cyclone raged; wind from N. by E.

There was a decided lull of half an hour, after which the tempest increased in violence, blowing from N. by W., and lasted till daybreak. The storm was at its height after 2-30 A.M.

Ghatal.—It appears that all the day of 15th the weather had a threatening appearance, with rain and wind. At 10 P.M. the cyclone commenced, with wind from the N.E. At 1 A.M. the wind changed to the S., then to the E., and again back to the S. There was no lull in the storm. At 1 A.M. the cyclone was at its height, and passed away at 5 A.M.

Tumlook Sub-Division.

Tumlook.—The weather was unsettled, with rain and wind from E., the entire day of the 15th. In the afternoon both wind and rain increased; and from 9 P.M. the cyclone commenced to rage, wind having veered to the N.E. It returned to E. and blew for upwards of two hours, after which it went to S.E., and about 2-30 A.M. the storm was at its height, when serious destruction was caused to houses and property. The storm broke at 4 A.M. There is no mention of any lull in the storm.

Panchkura.—There was rain and wind from N.E. during the entire day of the 15th. From 9 P.M. the cyclone commenced raging, till 11 P.M., from E. It then veered to S.E., and blew till 1 A.M., and from 1 to 4 A.M. from S., after which a westerly wind for 1½ hours, and with it the storm passed away. A partial lull of 15 or 20 minutes occurred about 1 A.M. and after it the cyclone was at its height, and serious destruction was caused to houses, &c.

Maslandpore.—The weather, all the 14th and 15th, was unsettled, with rain and high wind from the N. At 4 P.M. the wind blew from N.E., and the cyclone then commenced. From evening to midnight the wind blew mostly from E., and after that, till 4 A.M., from S.W. The height of the cyclone was from S.W. after midnight. About daybreak the storm broke: there was no lull.

Nundigram.—The weather on 14th and 15th was threatening. At noon of 15th the cyclone is reported to have commenced. Wind from N.E., veered at 11 P.M. to E. After midnight it blew from S.W. for an hour, and the storm passed off at 4 A.M., wind being then from the S. The storm was at its height from 10 P.M. to 2 A.M.; the wind was then S.W. There was no perceptible lull. The Kalinuggur embankment was broken, and serious inundations in several villages.

Sutahata.—There appears to have been but an ordinary blow, which damaged some of the police buildings and other houses, but no loss of human life or of cattle has occurred. Outpost Gewakhally police report mentions nothing of importance, except some partial damage to buildings. Outpost Balughatta police report slight damage to buildings.

Contai Sub-Division.

Contai.—The weather had been very ominous all the forenoon of the 15th, with rain and high wind from N.E. The cyclone raged from the afternoon to midnight, with wind in the same quarter, until the storm passed away with the wind blowing from the S. It had frequently veered between N.E. and S. There was no apparent lull during the cyclone. It raged without intermission.

Kedgiri.—The police make a similar report to that of Contai regarding the unsettled weather prior to the cyclone, and the period and direction from which it raged. There appears to have been no intermission or lull, and this station must have experienced the storm less severely. No deaths have occurred after due police enquiry. Two hundred and seventy-nine head of cattle have been destroyed.

Bhugwanpore.—The police make no mention as to the weather prior to the cyclone. They report that at noon of the 15th the cyclone commenced with heavy rain and strong N.E. wind, which momently blew with greater force, and thus the storm raged with the wind constantly changing between N.E., E., S., and W., levelling with the ground houses and trees; the police buildings have been totally destroyed

Rughoonathpore.—The weather had a threatening appearance from early morning of the 15th. About 10 A.M. the wind, which had been blowing from the N., now raged with great violence till 9 P.M., veering constantly between N. and W. Every building (houses or huts) has been almost all blown down.

Egra.—The weather had been unsettled all the 14th. The entire day of the 15th it rained, with a strong northerly wind. About 4 P.M. the cyclone commenced, with wind from N.E., which veered to E. and blew with great violence till 1 A.M.; then there was a decided lull of nearly an hour, after which the storm again raged from the W. till 4 A.M., when it passed away. The height of the cyclone is mentioned to have been about midnight, at which time the chief destruction occurred.

Pataspore.—The police report that there was heavy rain and high variable wind all day until the evening of the 15th, when the cyclone commenced blowing from N.E. and

lasted till 10 P.M., when there was a partial lull; after which, from 11 P.M. to 3 A.M., the storm raged from S.W. and then passed off. The height of the storm was between 9 P.M. and 2 A.M.

Extract from the Report of BABOO MOHANUND GOOPTO, *Deputy Magistrate.*

"*Pause at the middle.*—At Anundpore there was a quarter of an hour's pause in the middle of the cyclone. Storm first came from N.; after the pause it came from S.W.

"At Domrajpore, a village one mile west of Narajole, storm first came from N.E. There was a pause of about an hour at about 1 P.M. After the pause storm came from S.W. The direction of the wind must have come once from the W., for many trees were seen to have fallen towards the E.

"At Narajole there was a pause of nearly three-quarters of an hour in the middle of the cyclone.

"At Rajnagore there was a pause in the middle of the cyclone. Storm came from the N.E.; after the pause storm came from S.W. At Daspore storm came from N.E. There was a pause of nearly half an hour. After the pause storm came from the S. The trees are seen to have fallen towards the W. and the N. side. The direction of the wind must have changed from N.E. to E.

"At a village one mile north of Daspore trees seem to have fallen, their top towards the N.

"At Ghattal there was no pause in the middle of the cyclone.

"At Kheerpoy storm first came from N.E. There was a pause of nearly half an hour; storm then came from S.W.

"At Ramjebunpore storm came from N.E. About 2 o'clock there was a pause of half an hour; then storm came from S.W.

"At Jara there was a pause of half an hour. Exactly at 2-30 P.M. storm first came from N.E.; after pause, direct W.

"At Keshpore there seems to have been no pause.

"At Chandrakona storm came from N.E. At about 2 o'clock there was a pause of half an hour; then storm came from N.W., or rather from N."

Path of the vortex through the Midnapore District.—I shall now try and trace, as closely as possible, from the data, the progress of the vortex through the Midnapore district, and afterwards the extent of the storm on the western and eastern sides. I should premise that the police accounts are very inconsistent as regards the time of passage of the central calm over different places, and in some cases as regards the shifting of the wind. This is, however, what would be expected. Native estimates of time are, of all others, the most unreliable, especially at night; and I do not think the time of passage of the calm over different places as given in the police accounts can be trusted in some cases as even approximately correct.

Commencing at the south of the district, the first distinct lull recorded was at the police station of Egra. As Mr. Harrison remarks, the report as regards time is evidently wrong, and is altogether inconsistent with the reports from the surrounding places. At the police station of Rughoonathpore, about eight miles S. by W. from Egra, the violence of the storm is said to have been over at 9 P.M., and the central calm is reported to have passed Pataspore, 15 miles N. by W. from Egra, between 10 and 11 P.M. Egra is about 11 miles W. by N.$\frac{1}{2}$N. from Contai, where it has been seen the storm was nearest about 6-30 P.M. I would conclude, then, that about 7 P.M., or shortly after, the vortex was passing over Egra, and not at 1 A.M., as stated in the police reports. At 7 P.M. the wind was S.S.W. at Saugor Island, E.S.E. at Diamond Harbour, and E. at Calcutta—directions which are consistent with the supposed position of the vortex at the time.

The next place we hear of a lull is from the police station of Pataspore, 15 miles N. by W. from Egra. The lull is reported to have commenced about 10 P.M., and appears to have lasted about an hour. The time as stated seems to be approximately correct, but about an hour earlier would be more consistent with the rate of progress of the storm, which, in this latitude, was not more than about 7 miles an hour.

The police station of Sabhang, from which the next lull is reported, is about 12 miles N.N.E. of Pataspore and about 37 miles due E. of Diamond

Harbour. A perfect calm commencing at 2 A.M., and lasting for an hour, is recorded. The time here as stated is evidently considerably in error. The lowest reading of the barometer recorded at Diamond Harbour was at 9-45, and when next observed at 10-55 it had risen slightly. The direction of the wind at Diamond Harbour was about this time S.E. veering to S.; at Calcutta about E. by S.; and at Saugor Island S.S.W. From these data, and the general rate of progress of the storm, it appears that the vortex must have been passing over Sabhang between 10 and 10-30 P.M., the centre probably a little to the westward.

Debra is nearly 15 miles N. by W. from Sabhang, and 15 miles W.½S. from Midnapore. Here the police report a sudden lull commencing at 2 A.M., and lasting for half an hour. The time is not consistent with the observations at Midnapore and other places. Mr. Harrison in his first account fixes 12 P.M. as the time when the storm was at its maximum at Midnapore, the wind being then between N. by W. and N.N.W. In his final report he gives 1 A.M. as the probable time when the lull commenced at Debra. I should take the mean of his two estimates as the most consistent with the general progress of the storm, and say that about 12-30 A.M. the centre of the vortex was passing a little to the E. of Debra, and was then nearest to Midnapore. At this time the wind at Diamond Harbour was about S., at Calcutta S.E., and at Saugor Island S.W. It is remarkable that at Panchkura, 10 miles due E. of Debra, a partial lull is said to have taken place at about 1 A.M., and lasted for about 15 minutes. The time very nearly corresponds with the supposed time of passage of the vortex over Debra. The wind is stated to have been S.E. when the lull commenced, having veered round to that point from E., and it would seem that Panchkura was only intersected by the eastern edge of vortex. Round the central calm there appears to be in cyclones an intermediate belt in which the force of the wind is much less than further from the centre, and it was this belt which probably crossed Panchkura. This would give a diameter of not less than about 15 miles to the vortex, including the comparatively calm ring mentioned above. It is possible, however, as will be seen further on, that not only was the vortex very variable in diameter, but that it oscillated considerably to the eastward and westward of its mean path.

Narajole is a village 12 miles N. by E. from Debra. Here Baboo Mohanund Goopto's report states that there was a pause of nearly three-quarters of an hour in the middle of the cyclone, time not stated. At Domrajpore, a village one mile W. of Narajole, a pause of about an hour, commencing at 1 A.M., is recorded. The time is probably very nearly correct, and the centre of the vortex was probably passing a little to the W. of Narajole about 1-30 A.M. At Keshpore, 9½ miles W.½S. of Narajole, the police report a partial lull commencing at 3 A.M. However, the Deputy Magistrate's enquiries led him to conclude that there was no pause at this place, and the police report, as regards time, is evidently altogether wrong.

Kheerpoy is 10 miles due N. of Narajole. A pause of half an hour is reported at this place, time not stated. The police station of Chundrakona is about 6½ miles W. by N., and that of Ghatal 7½ miles E.S.E. from Kheerpoy. At Chundrakona, it is stated that there was a decided lull of half an hour commencing at 2 A.M. The time for the commencement of the lull is probably very nearly correct. There was no lull at Ghatal. However, at Daspore, about four miles due S. from Ghatal, there was a partial lull, commencing at 2 A.M., and likewise a lull at the village of Rajnagore, about midway between the above places, but a little to the westward of the direct line. About this locality, just before the storm commenced to move to the N.N.E. over Burdwan, the course of the vortex (supposing that there was only one vortex and not a succession of different vortices) appears to have been either very variable in diameter or very irregular in its path. Supposing the diameter of the vortex to have been constant, it would take one of at least 17 or 18 miles to cover Daspore and Chundracona, allowing for the curvature of the path. But this diameter would well include the police station of Ghatal, where no lull was felt. Judging, however, from the duration of the lull, as recorded at different places, and the rate of progress of the storm, the diameter

of the vortex could not have been nearly as large as 17 miles. Considering that shortly after this time the central calm was felt at Jehanabad, and later on passed over the town of Burdwan, and that it skipped Ghatal but was felt at Daspore and Chundracona, it appears as if the vortex was not only variable in diameter, but also oscillated considerably to the westward and the eastward of its mean track. The observed facts, however, might be explained by supposing the progression of the storm to be caused, not by the continuous motion of one vortex, but by the continuous formation of successive vortices along an irregular path.

At the village of Jara, E.N.E.$\frac{1}{2}$N. from Chundracona, about five miles, a lull of half an hour is stated to have begun exactly at 2-30 A.M. Before the pause the wind was from N.E., afterwards from W. The time given agrees very well with the time, 3-15 A.M., when the lull was first felt at Jehanabad, 16 miles N.E.$\frac{1}{2}$E.; and the wind directions before and after the calm are also quite consistent with the north-north-easterly course of the storm at the time. At the village of Ramjebunpore, on the borders of the Burdwan district, and five miles N.N.E. of Jara, a lull for half an hour was felt. The time when it began is given as about 2 A.M. It was probably half an hour later than this.

I have now traced the vortex (or succession of vortices?) to the boundary of the Burdwan district, over which it passed about 2-30 A.M. of the 16th, its eastern edge, just including Jehanabad, from 3-15 A.M. to 3-30 A.M., and the centre probably passing very close to Goghaut, a police station about five miles west of Jehanabad. The mean path of the centre of the cyclone may be shown by drawing a mean curve through the places which are given in the following list, with their latitudes and longitudes, commencing from the south of the district. The towns of Burdwan and Berhampore may be added to complete the curve—

Place.	Longitude.	Latitude.	Place.	Longitude.	Latitude.
Rughoonathpore ...	87° 37′	21° 42′	Narajole	87° 40′	22° 33′
Egra	87° 38′	21° 50′	Keerpoy	87° 40′·5	22° 43′
Pataspore ...	87° 36′	22° 2′	Jara	87° 38′·5	22° 46′
Sabhang	87° 40′	22° 11′	Ramjebunpore ...	87° 40′	22° 50′
Debra	87° 37′	22° 24′	Goghaut	87° 41′	22° 53′

Rate of progress of the Cyclone in the Midnapore District.—It has been seen that the barometer at Contai was lowest at 6-18 P.M. We may assume that the centre was due west from that place about 6-30 P.M. From this latitude to Debra the distance is 44 miles, and, taking 12-30 A.M. as the time when the centre was over Debra, the mean rate of progress between these places would be 7$\frac{1}{3}$ miles per hour. The distance from Debra to Goghaut is about 35 miles. Allowing for curvature, we may take the distance travelled by the centre of the vortex between these places as about 37 miles in three hours, giving a mean rate of 12$\frac{1}{3}$ miles an hour.

West of the path of the vortex.—Mr. Harrison's tabular statement showing the relative destructive effects of the storm on the western and eastern sides of the path of the vortex, and his remarks thereon, render it necessary for me to add little on the subject. It will be remarked that the cyclone did not extend as far west as the jungle mehals, Beenpore, Jhargram, and Gopeebullubpore, although parts of the latter thana were within a distance of 25 miles from the path of the centre of the vortex. The police station of Jhargram is about 20 miles due west of the town of Midnapore, and about 35 miles west of the mean track of the centre of the cyclone. Here there was not only no heavy gale, but the high wind, which had lasted for about 24 hours before the cyclone, seems to have subsided just when its centre was nearest. The same appears to have been the case all along the western side of the storm, in the Balasore and Midnapore districts, outside the destructive belt, which could not have extended much further than about 23 miles from the mean path of the centre. All the accounts agree that a high wind blew for about 24 hours before the storm, but rapidly subsided as the storm passed. On the other hand, on the eastern side of the path of the centre, a strong gale of wind extended at least as far as 50 miles or thereabouts, and continued for a considerable time after the centre of the storm was nearest.

The cause of the greater force of wind on the north-western side of the cyclone appears to be connected with the course of the currents converging to the vortex, and the difference in the atmospheric gradients to the south and to the north of the storm's latitude at the time. The circular theory of cyclones has for some years been mostly abandoned by meteorologists. There can be no doubt that the course of the wind is not circular, but spiral. Mr. Harrison seems to have discovered this fact for himself, and his remarks on the subject are highly interesting. He writes:—"I do not know whether the surmise is scientifically possible, but the indications in this district lead to the inference that instead of the wind describing a circle, or being nearly circular, it describes a curve, more like that of a six (6),* the greatest power being at the first bend of the six opposite the vortex." Again he says:—"It would thus seem as if the wind swept down from the N.E. in almost a straight line, at a constantly increasing rate, till it reached the level of the vortex, when it was at its maximum." The above remarks describe with sufficient accuracy the course of the wind towards the vortex. At a considerable distance, the wind appears to move in lines very slightly curved—on the northern side from N.E., and on the southern side from the S.W. As the wind approaches the vortex, the curvature of its path becomes more considerable, until it at last enters and is carried up as an ascending current. This would account for the fact that the maximum force of the wind is at some distance from the central calm, and not at its limits, as generally supposed. The velocity of the wind is considerably retarded before it is ultimately forced upwards; and just outside the central calm the principal component of the wind's force is vertical, and hence the surface wind is not so powerful. The greater force of the wind on the north-western quadrant of the storm is, I think, explained by the greater sharpness of the atmospheric gradient to the north of the storm compared with the gradient to the south. It has been shown that, north of the storm, the barometer continued high until the cyclone was near at hand; whereas the atmospheric depression caused by, or accompanying, the passage of the storm was not filled up to the southward until a considerable time after it had passed by. The wind currents approaching the vortex on the north-western side would come from N. or N.E., and would move (so to speak) down a steeper incline than those approaching the vortex on the south-eastern side, which would have come up from S. or S.W."

East of the track of the vortex.—As has been already stated, Saugor Island was about 29 or 30 miles to the east of the mean path of the centre of the vortex, but even at this distance there was a very heavy gale during the passage of the storm. Further to the northward, Kedgiri, 26 miles east of the central line, appears to have been about at the eastern limit of the destructive part of the hurricane. No deaths are reported, but there was considerable loss of cattle and destruction of property.

Tumlook, about 23 or 24 miles from the central line, was within the destructive belt, and a very heavy gale extended beyond Diamond Harbour, 40 miles east of the mean track. The Collector of the 24-Pergunnahs gives, in his report, the following observations made by the Telegraph Master at this place. The barometric readings are unreduced for temperature, and the barometer has not been compared:—

Date.	Hour.	Barometer.	Wind direction.
14th October		... 29·82	... N.E.
15th	8 A.M.	... 29·79	... „
	2-4 P.M.	... 29·66	... E.N.E.
	3-30 „	... 29·62	... „
	4-30 „	... 29·55	... Shifting to E.
	5-30 „	... 29·55	... E.
	6-30 „	... 29·55	... Shifting to S.E.
	9-45 „	... 29·53	... S.E.
	10-55 „	... 29·55	... „
	11-50 „	... 29·58	... „
16th	1 A.M.	... 29·60	... Shifting to S.W.

The barometrical observations were taken at the Post Office, Diamond Harbour.

At Calcutta, about 50 miles east of the nearest point of the mean path of the storm, the wind was never much stronger than a moderate gale. The maximum

* As the figure is commonly written not as it is printed.—W. G. W.

pressure recorded at the Surveyor-General's Office was 12 lbs. on the square foot (corresponding to a velocity of 49 miles an hour) in a squall at 9-45 P.M. The mean velocity of the wind between 9 and 10 P.M., as given by the self-registering anemometer at the meteorological office, was about 45 miles an hour. Between these hours the direction was variable between E. by N. and S.E. That is, the wind varied through two or three points in the squalls. On the whole, however, taking its mean direction, it veered steadily round as the storm passed by. The lowest reading of the barometer recorded was at 2 A.M., 29·486, reduced for temperature. At this time the mean direction of the wind was S. E. by S., and the bearing of the centre, near Keerpoy, W. by N., giving an angle of 12 points between the wind and the direction of the centre of the storm; taking the extreme directions of the wind the angle would lie between 10 and 14 points.

The following table shows the mean direction of the wind and its velocity in miles per hour from the preceding hour, as taken from a self-registering instrument at the meteorological office, Calcutta. The extreme points between which the wind varied are also shown in two parallel columns. It will be seen that the greatest mean velocity of the wind was between 9 and 10 P.M., when the storm's centre was about S.W., and four hours before its nearest approach. Between 10 and 11-30 P.M. the mean velocity of wind decreased considerably; and, as will be seen from the annexed table of barometric readings, there was also a slight increase of pressure. From midnight, however, the barometer again fell slightly up to 2 A.M., when the lowest reading was recorded. There was also a corresponding slight increase in the velocity of the wind, but it never reached anything like its force between 9 and 10 P.M. The remarkable rise of the barometer at Calcutta from 10 to 11-30 P.M., for which I can vouch, as I took careful readings at the time at intervals of quarter of an hour, does not appear to have any connection with the ordinary diurnal oscillations. It may have been due either to a temporary increase of the atmospheric pressure at the vortex as it moved slowly from Pataspore towards Debra, or there may have been about this time a gradual permanent decrease in the intensity of the cyclone (there certainly was a rapid decrease in the intensity of the storm later on as it passed through the Burdwan district), the apparent effect of which, however, was partially obliterated as the storm approached nearer to Calcutta.

Direction and velocity of wind as taken from anemograph curves traced out by a self-registering instrument at the Meteorological Office.

October 1874.	Hour.	Mean direction of wind.	Wind varying		Mean velocity in miles per hour from previous hour.
			From	To	
15th	4	N.E.	.....	.....	.....
	10	E. by N.	E.N.E.	E.	8
	11	E.N.E.	.....	.....	.....
	12	E. by N.	N.E.	E.	14
	13	E.N.E.	.....	.....	.....
	14	E.N.E.	.....	.....	15
	15	E. by N.	E.N.E.	E.	15
	16	E. by N.	E.N.E.	E.	17
	17	E. by N.	E.N.E.	E.	20
	18	E. by N.	E.N.E.	E.	20
	18-30	E.N.E.	N.E.	E.S.E.	.....
	19	E.	E. by N.	E. by S.	33
	20	E.	E. by N.	E.S.E.	30
	21	E. by S.	E. by N.	S.E. by E.	33
	22	E.S.E.	E.	S.E.	45
	23	S.E. by E.	E. by S.	S.E. by E.	40
	24	S.E.	E.S.E.	S.S.E.	25
16th	1	S.E.	E.S.E.	S.S.E.	35
	2	S.E. by S.	S.E. by E.	S. by E.	30
	3	S.S.E.	S.E.	S.	30
	4	S. by E.	S.E.	S. by W.	20
	5	S.	S.E. by S.	S. by W.	20
	6	S. by W.	S. by E.	S.S.W.	20
	7	S.S.W.	S.	S.W. by W.	20
	8	S.S.W.	S.	S.W.	20
	9	S.W. by S.	S.S.W.	S.W.	20
	10	S.W. by S.	.....	.....	18
	11	S.W.	.....	.....	15
	12	S.W.	.....	.....	20
	13	S.W. by W.	.....	.....	20
	14	W.S.W.	.....	.....	17
	15	W.S.W.	.....	.....	15
	16	W. by S.	.....	.....	15

Interrupted Barometrical Observations made at No. 3 Albert Road.

October 1874.	Hour.	* Barometer No. 714 reduced for temperature.	Attached thermometer.	Remarks.
14th	15·50	29·737	85	Wind which had been light all day from N.E., with a cloudless sky, now suddenly gone round to E. and S.E., light breeze and overcast.
	2·10	29·708	82	Slight squall from N.E., with a little rain.
	8·35	29·752	80	
	10	755	80	
	12	683	80	
	12·40	645	80	
	19	546	80	
	19·30	561	80	
	21	519	80	Blowing hard from E. and E.S.E., with some heavy gusts.
	21·15	514	80	
15th	21·40	510	79·7	Wind the same.
	22	497	79·7	Torrents of driving rain. Wind not increased since 9 P.M.
	22·15	500	79·7	Wind somewhat moderated. Rain in torrents. Barometer rising.
	22·30	513	79·6	Wind decidedly less, and going round more to S.; torrents of rain.
	22·45	518	79·5	Wind stronger, S.E. by E. Less rain.
	23	520	79·3	Rain heavier than before. Torrents with each squall; then ceases for a few moments, and then comes on again. Wind, a strong gusty breeze.
	23·15	526	79·2	Wind as before, and from S.E., with torrents of rain.
	23·30	534	79·3	Rain heavier than ever; wind as before. Barometer risen considerably since 10 P.M.
	5·30	531	79	Wind southerly. No rain, moderate breeze.
	6·20	586	79·5	Wind S., moderate breeze, drizzling.
	6·45	605	78·4	Moderate breeze from S.S.W.
16th	7	604	78·3	
	9	678	79	Moderate breeze from S.W.
	9·35	692	79	
	10	698	79	

* The correction of this instrument to the Calcutta standard, including that for difference of altitudes at the time, is not quite accurately known, but is very nearly + 0·020, which should be added to the above readings for comparison.

The following table is an extract from the detailed observations made at the Surveyor-General's Office (Calcutta Observatory). It will be noticed that the wind directions do not agree with those given in the former table, and I am unable altogether to account for the differences. In this discussion I have only used the directions as given in the former table. The distance between the two places, which is not more than half a mile, would not account for the discrepancies.

Extract from observations taken at the Surveyor-General's Office, Calcutta.

October 1874.	Hour.	Calcutta standard barometer reduced for temperature.	Hygrometer.		Wind.		Rainfall.	Clouds.	Weather Initials.
			Dry.	Wet.	* Pressure in lbs. per square foot.	Direction.			
14th	4	29·747	78·5	74·4	.....	E.	.....	C.	.....
„	10	29·817	87·0	79·0	.....	E.N.E.	.....	C.	.....
„	16	29·749	82·7	77	.....	S.E.	.....	K.	.....
„	22	29·783	78·6	76	.....	S.E.	.....	S.	.....
15th	4	29·709	78·0	76·5	.....	N.E.	.....	.....	o.
„	10	29·772	78	77	.....	E.N.E.	.....	.....	o, r.
„	11	29·740	79	78	.....	E.N.E.	.....	.....	o, d.
„	12	29·708	78·5	77·5	.....	E.N.E.	.....	.....	o, r, t.
„	13	29·680	79	78	1·2	E. by N.	.....	.....	o.
„	14	29·657	79·7	78·3	1	E.	.....	.....	o.
„	15	29·627	79	78	.....	E.	.....	.....	o, d.
„	16	29·615	79	78	2	E.	1·27	.....	o, d.
„	17	29·606	78·5	77	1	E.	.....	.....	o, d.
„	18	29·570	78	77·3	5	E.	.....	.....	o, r.
„	19	29·568	78·5	77·5	7·8	E.	.....	.....	o, d.
„	20	29·577	79	77·5	6	E.	.....	.....	o, d.
„	21	29·540	78·5	77·4	8	E. by S.	.....	.....	o, r.
„	21·50	29·531	.....	.....	.....	E.S.E.	.....	.....	.....

* Shows the maximum pressure recorded since previous hour.

Extract from observations taken at the Surveyor-General's Office, Calcutta—(Continued).

October 1874.	Hour.	Calcutta standard barometer reduced for temperature.	Hygrometer.		Wind.		Rainfall.	Clouds.	Weather Initials.
			Dry.	Wet.	* Pressure in lbs. per square foot.	Direction.			
15th	22	29·535	78	77·4	†12	E.S.E.	.....	.....	*o, r.*
„	22·10	29·521	.....	.....	.....	E.S.E.	.....	.....	.....
„	22·20	29·531	.....	.....	.....	E.S.E.	.....	.....	.....
„	22·30	29·521	.....	.....	.....	S.E.	.....	.....	.....
„	22·40	29·531	.....	.....	.....	S.E.	.....	.....	.....
„	22·50	29·531	.....	.....	.....	S.S.E.	.....	.....	.....
„	23	29·539	77·5	77·3	11	S.S E.	.....	.....	*o, r.*
„	23·45	29·539	.....	.....	.....	S.	.....	.....	.....
„	24	29·531	78	77	9·6	S.	.....	.....	*o, r.*
16th	1	29·508	77·5	76·5	10	S.	.....	.....	*o, r.*
„	2	29·486	77	76·5	10	S.	.....	.....	*o, r.*
„	3	29·494	77·2	76	10·2	S.	.....	.....	*o, r.*
„	4	29·520	77·5	76·4	10	S.	.....	.....	*o, d.*
„	5	29·534	77·5	76·4	10	S.	.....	.....	*o, r.*
„	6	29·581	77·5	75·5	9·6	S.W.	.....	.....	*o, r.*
„	7	29·611	77·5	75·5	5	S.W.	.....	.....	*o, d.*
„	8	29·659	78·3	75·8	4	S.W.	.....	.....	*o, d.*
„	9	29·691	79·6	76·6	2·5	S.W.	.....	.....	*o, d.*
„	10	29·704	79 0	76·5	2	S.S.W.	4·56	.....	*o.*
„	16	29·671	82·4	77	.....	W. by S.	.....	S.	*b.*
„	22	29·770	78·0	76·6	.....	W.S.W.	.....	.....	.....

* Shows the maximum pressure recorded since previous observation.
† Maximum pressure of 12lbs. on the square foot at 9-45 P.M.

The destructive part of the eastern side of the storm passed over a small portion of the Hooghly district. Nine deaths resulting from the cyclone only were recorded. However, houses and trees suffered severely almost all over the district, and 43 boats laden with jute, salt, rice, and miscellaneous cargoes were wrecked in the Hooghly between Gooptiparah, on the north, and Ootterparah, on the south. Mr. F. H. Pellew, Collector of Hooghly, writes in his report on the cyclone:—

"At Hooghly the wind, which had been blowing from the N.E. all day on the 15th, began to get violent at 9 P.M. My barometer, which, however, requires a correction of about 0·213 (to be subtracted) fell from 30·030 at 10 A.M. to 29·750 at 10 P.M. At 2 A.M. of the 16th the wind was violent from E. (E.S.E. ?), and at 4 A.M. it was violent from the S.E., and the barometer was at 29·610. The wind then lulled and veered to the S. at 8 A.M.; it was quite moderate from the S.S.W.

"The centre of the cyclone, which passed near Debra, Kirpai, Goghat, and Burdwan, moving in a direction a little east of north, would seem to have never been within 15 miles of the boundary of this district. The thana which it approached nearest to was Dhuniakhally at about 4 A.M., when it may have been within 22 miles. It probably passed Kristonaghur within 26 miles at about 2 A.M., and Hurripal at about the same distance a little later."

In a letter to the *Englishman*, written a few days after the storm, Mr. Pellew gives the wind directions at 10-30, 11 P.M., and 2 A M as E.N.E., E., and E.S.E., respectively. The course of the storm, which I have sketched, is consistent with the above wind directions, and with the times which Mr. Pellew gives of its nearest approach to the police thanas of Kristonaghur and Dhuniakhally.

It will be seen from the above that a strong gale extended as far as the town of Hooghly, 43 miles to the east of the track of the centre of the cyclone. But the storm was felt as a moderate gale, gradually decreasing with the distance, to a strong gusty wind as far as Satkhira in the 24-Pergunnahs, and the town of Jessore, or as far as about 80 or 90 miles east of the path of the centre.

Burdwan District.

The greater part of the information which has reached me in connection with the progress of the cyclone through the Burdwan district is summarized in the following report by Mr. Whinfield. Annexed is an extract giving an interesting account of the upsetting of the down passenger train by the force of the wind at about 4 A.M. of the 16th, one mile from the Kanoo Junction. Some additional data, mostly of a fragmentary character, will be inserted as required in the sequel.

Extract from a report of MR. E. H. WHINFIELD, *Collector of Burdwan, to the Government of Bengal.*

Sudder Sub-division.—The Civil Surgeon reports as follows:—"During the cyclone of the 15th and 16th October 1874, no observations of the mercurial barometer were made here, except at 10 and 16 hours of the 15th. The barometer (corrected and reduced to 32°F.) was at 10 A.M. of that day 29·733, and at 4 P.M. it was 29·592. The daily range of the maximum and minimum thermometers was 2·5 on the 15th. No observation was made at 10 o'clock A.M. of the 16th while the storm was going on.

"The storm commenced from 8 o'clock P.M. of the 15th and ended at 12 o'clock of the 16th. The direction of the wind was very variable during the fortnight ending 15th October 1874. On the afternoon of the 15th the wind was N.E. Towards evening the wind began to rise from this direction until about 9 or 10, when it became very violent. The greatest violence of the cyclone was in the early morning hours of the 16th, and at this time the direction of the wind was as near as possible due E. About half-past 5 or 6 a pause occurred of about an hour's duration, after which the storm again began to blow, but this time from the W. About 9 A.M. I observed that the wind was coming from the S.W., but during the greater part of the second part of the storm (which ended about noon of the 16th) the wind came directly from the W. This second half of the storm, though violent, did not attain the fury of the previous E. wind. The storm was throughout accompanied by rain, which, when measured after the cessation of the cyclone, was found to have fallen to the amount of 6·65 inches.

"Many very large trees were uprooted and others broken. The great majority of these pointed to the W. but several, and some of these of large girth, pointed to the S.W. Very few pointed to the E., and they were of small size (young trees, bamboos, &c.); in fact, the furious E. wind that had just before prevailed had blown down all the trees capable of being blown down. Nor had the W. wind the strength of the E.

"The Banka, Darkessur, and Bhagiruthee overflowed their banks, but the floods of the first-named rapidly subsided. The area of the *greatest* destruction was from Pannaghur in the W. to Mymaree in the E., and from Cutwa in the N. to Gourhatty in the S. *i.e.*, the greater part of the district. But, as far as I can judge from the still very meagre reports received, there was not the same amount of destruction of life and property as in Midnapore."

I concur generally with the Civil Surgeon's remarks; only I would add that I did not observe any interval in which the wind was *completely* lulled, and it appeared to me for a short time in the morning to blow from the S. or S.E. Some windows on the S. side of the house I occupy have been blown in. At Mymaree, in the extreme E. of the Sudder sub-division, I was told the wind had blown from the S. for some time. My observations (on an aneroid barometer*) were, on the 15th at 11 P.M., 29·02; on 16th at 6 P.M. 28·03.

Raneegunge.—The Raneegunge Sub-division was not affected by the storm.

Bood-bood.—The Bood-bood Sub-divisional Officer reports as follows:—"From the evening of the 15th instant the wind blew from the N.E. and gradually increased in force; after 12 o'clock on the 16th instant, *i.e.*, at 1 A.M. on the morning of the 16th instant, the cyclone began and increased with considerable violence, the wind blowing then directly from the N. At the strongest part, 3 to 5-30 A.M., its direction was N.W. There was, at about 5-30 A.M., a calm or lull, which lasted for a quarter of an hour. It renewed again with violence and blew from the N.W. till 8-30 A.M., after which it moderated in force and continued till 10 A.M. The total rainfall on the night of the 15th and morning of the 16th instant was 8·40, and the tanks and rivulets Koonoor, Khurree, Banka, and Kookooi were all overflown, and the water stood over the road leading to the thana from this Sub-divisional office, and made breaches on the road, made as relief work, by the strong current of water at points where there are spaces for culverts. The water stood two feet high over the Grand Trunk Road from Oara to Golegram, a distance of six miles. The effects of the cyclone were that 17 human lives were lost in villages in thana Bood-bood by fall of houses on the morning of the 16th, and 57 cattle and 593 goats and sheep are reported to have died in consequence of it. In the three thanas of this sub-division, the following is a statement of the number and value of houses destroyed:—

	Number of houses.	Value.
		Rs.
In thana Bood-bood	23,312	2,48,011
In thana Sonamookhy	3,475	23,575
In thana Ausgram	13,303	1,31,120

"Besides these, large trees fell on sides of the Grand Trunk Road in gardens and in the villages, and fishes of tanks were lost by the cyclone. The number of houses destroyed, and of those of which thatches are blow off, as also of the number of trees fallen, appear larger towards the eastern part of this sub-division than towards the western part."

I have myself visited Bhedia, in the extreme N.W. of the sub-division, and Bood-bood itself since the storm. At the former, trees had been blown down from the N. and

* Correction to be added 0·45 as compared with Calcutta standard.—W. G. W.

I heard that the storm had not been felt at Illam Bazar, eight miles to the W. of Bhedia. The storm has not done so much damage in Bood-bood as elsewhere.

Cutwa.—The Sub-divisional Officer reports:—"Yesterday in the morning the sky looked hazy, and about 7 in the morning there was drizzling rain which ceased at intervals. The state of the weather remained unsettled till late in the evening, when signs of a coming storm were observed. After sunset there was a strong wind from the E., but still the rain seemed to keep off. About 2 o'clock in the morning there was pelting rain with high wind from the same direction. Before 6 o'clock it turned towards S.E., when its violence increased. The cyclone was at its greatest intensity between 8-35 to 10-45, from which time it commenced to abate. About a quarter past 4 o'clock in the afternoon the wind changed to W., and then to due S., after which it ceased, though there was some rain even after its discontinuance. The rain-gauge measured a fall of 4·30 at Cutwa, but I have reason to believe that it was still heavier in some parts of the sub-division, where it commenced earlier."

I have visited Cutwa since the storm, and found trees blown down from the S. It is noticeable that the storm seems to have reached this place later than places further S.

Culna.—"The Culna Deputy Collector reports as follows:—"The morning of the 15th instant broke calm, with low grey clouds. Rain began to fall at 6-30 A.M. There was no wind at that time. Rain and a light breeze continued all the day; breeze blowing from the N.N.E., or N.E. by N. About 4 P.M. the wind commenced to increase in force, and continued to do so, shifting a point to the E. By 10 P.M. a moderate gale was blowing from N.E., after which (time being uncertain) it appears to have shifted almost due E. At 5 A.M., on the 16th instant, there was a strong gale blowing from the E or E. by N. At 7 A.M. it suddenly turned to S.E. from which quarter it continued to blow till 10 A.M., when it began to decrease. So far as I can judge, the greatest force of the storm was about from 3 A.M. to 4 A.M. of the 16th instant, the direction being E. or E. by N. There was no lull of any duration, but the character of the wind was fitful and gusty, though there was only a minute or a minute and a half between each gust. The way I judge that the wind blew due E. in the middle of the night (probably at about 3 A.M.) is this. I noticed an entire plantation of plantain trees swept down from E. to W.; and the direction in which these trees lay as clearly indicated the direction of the wind as a weathercock could have done. My own opinion is that we at Culna were not touched by the cyclone at all, but merely by the air swell proceeding from the disturbance caused by it: hence the small injury. Its devastations have been little more in other parts of this sub-division."

Jehanabad.—The Jehanabad Deputy Collector reports as follows:—"In the morning of the 15th instant the day was cloudy, dark, and sky overcast, with frequent short rain. In the afternoon there were short frequent showers, and the weather was very gloomy. Rainfall noted up to 6 P.M. 0·94. The wind began to blow from E. by N. At 4 P.M. it was a little increased in force and velocity. From 8 P.M. it increased steadily as the night advanced, with frequent heavy showers, reaching its maximum by 1-30 A.M., when it veered round to the E. and blew as furiously up to 3 A.M.

"At 3-15 A.M. there was a distinct calm or lull, the duration of which was 15 minutes. At 3-30 A.M. the wind blew from N.W., increasing in force as it veered round to the W. and at last to the S.W. It reached its maximum velocity at 4-30 A.M.; but the force was not equal to the other, blowing with unabated violence up to 5-45 A.M., when it began to abate. At 11 A.M. the weather was clear. Total rainfall noted on the 15th and 16th morning, 4·89 inches."

I have visited Jehanabad since the storm, and consider that the damage done to houses there is greater than anywhere else, except perhaps Burdwan.

Loss of life.—The police have reported the following number of deaths in each of the thanas affected by the storm:—

Names of thanas.	Number of deaths.
Cutwa	1
Ketugram	0
Burdwan	6
Ganguriah	0
Selimabad	2
Sahebgunge	3
Khundghose	10
Indus	11
Bood-bood	16
Ausgram	0
Sonamokhy	0
Jehanabad	9
Kotulpore	27
Poorbusthally	0
Goughat	14
Total ...	99

Damage to houses.—The police reported no less than 131,398 houses as ruined by the storm; but these figures are based only on imagination. The number of houses entirely ruined in the municipality of Burdwan has been carefully computed to be 5 per cent., and the number of houses unroofed or partially damaged to be 15 per cent. As the storm was certainly not much more severe anywhere than in the town of Burdwan, these figures afford a basis for calculating the outside amount of damage to house property in the five sub-divisions affected by the storm as follows :—

Number of houses by census in Burdwan, Cutwa, Culna, Jehanabad, and Bood-bood Sub-divisions ...	1,08,388	20 per cent. ruined or damaged ...	21,677·6.

Extract of a letter from MR. WHINFIELD, *Collector of Burdwan, to the Commissioner of the Division.*

I HAVE the honor to report for your information that No. 10 down passenger train was over-turned on the morning of the 16th instant at 76¼ mile, about a mile above Kanoo Junction station.

The Assistant Inspector-General, Government Railway Police, reports as follows:—

"On the morning of the 16th I left Sitarampore by No. 1 down slow passenger, and on arrival at Raneegunge heard that telegraphic communication had been stopped, and that no messages could be sent to Burdwan or Calcutta. The No. 1 down passenger proceeded on her way down, and from Paneeghur it was evident that a very severe storm had passed over the country, as the destruction to trees, telegraph posts, and the like, began to be apparent. We reached Mancoor all right, and went on towards Burdwan. On arrival at about the 80th mile, a guard with a red flag was seen standing, and so the driver of No. 1 slackened his speed, and after running over two fog signals, which had been laid down, brought his train to a stand. I then got out of the train, and proceeding to the front found that No. 5 goods was before us; before No. 5 was No. 22 goods, and before that again was No. 10 down passenger, to which an accident had occurred. I proceeded to the down passenger, which was close to the 76th mile, and there found the guard of the train. The train had consisted of engine and tender, a front brake-van, 10 carriages, 12 wagons, one horse-box, and a rear brake-van. The engine and tender had gone on to Burdwan. I found the front brake, all the carriages, and wagons upset, lying on their right sides on the up line, and only the horse-box and rear brake-van standing on the lines of the down side. This train seems to have left Raneegunge on the 15th at 23-15 o'clock. The wind at that time was very high, and much impeded the progress of the train; in fact so high was the wind that at times the train was brought to a dead stand. The train made way to Mancoor all right, and left that for Kanoo; the wind increased, and at last the wind got to be so strong that it brought the train to a dead stand. On seeing this the guard got out of his van, and tried to go back so as to protect his train. The night, I must here remark, was very dark, and it was raining in a regular downpour. The guard on endeavouriug to go back was blown down, and found himself unable to proceed. He crawled back to his van, and then, steadying himself by holding to the vehicles, made a move to the front of his train. He passed the horse-box and two wagons, and then found that the next wagon was upset; and going on further, found that the rest of the train with the front brake had all been upset on to the up line, and the engine and tender were gone. The accident occurred about the 76¼ mile, *i.e.*, about a mile from Kanoo Junction. It must here be stated that after the guard left his rear brake, and to the time he again returned to it, the two rear wagons which had been left standing were blown over, and he found the horse-box and his own van still erect. The wind after this lulled, and no further damage was done. The guard, after duly protecting his train, went on to Kanoo, and from there returned on the engine with station-master Perkins and guard Agden. On arrival back the guard went along the train, and made enquiries, and found that fortunately no lives had been lost. One European woman in the European compartment of a third class carriage complained much of her injuries, and a Native of a broken arm; some other passengers were more or less bruised and hurt. After this the engine went back to Burdwan, and returned with the Civil Surgeon, a native doctor, the station-master of Burdwan, and two carriage examiners with staff and some carriages attached. On the arrival of the train the passengers were nearly all out of the train, having made the best of their way out by the window and upper doors. The passengers injured who could not get out were removed out by the railway staff, and then taking part of the luggages the train started back for Burdwan. The injured persons were all attended to by the Civil Surgeon and his assistant; and with the exception of the injured European woman, one Native passenger, and Government Railway Police Inspector McLean, who has his shoulder hurt, all the other passengers, though the injured men were advised to stay in hospital, proceeded on their way."

Path of the vortex.—Commencing at the south of the district, the following list of places at which there was a distinct history of a lull is given by the

Inspecting Medical Officer of the Jehanabad Circle in a letter to the Civil Surgeon of Burdwan:—

Hajeepore,	calm after	2 A.M.,	lasted	¼	of an hour.	
Bally	"	" 2½	"	"	¾	"
Jehanabad	"	" 3	"	"	¼	"
Akloky	"	" 3¼	"	"	¾	"
Digulgram	"	" 3½ or 4 A.M.,	lasted	½	of an hour.	

At these places the wind was said to be westerly after the lull.

Hajeepore is on the border of the Midnapore district, about two miles E. of Ramjeebunpore, where a lull occurring at the same time and lasting for the same period was recorded. Bally is due E. 10 miles from Hajeepore and 4½ miles S. of Jehanabad. A partial lull was also felt at Myapore, five miles E. from Jehanabad; but the wind was southerly after the calm, showing that the vortex only just touched the place. The Deputy Collector of Jehanabad gives the time when the calm commenced there as 3-15 A.M., and states that it lasted for quarter of an hour. It appears, however, from his account that the wind decreased from 3 A.M., and that after 3-30 A.M. it re-commenced from the westward and gradually increased again in force as it backed towards S. It seems improbable that the direction of the wind after the lull was N.W. as stated, except, indeed, the course of the centre of this vortex was E.N.E. at the time. This, however, may have been the case. It is difficult to account for the calms at the different places where they have been recorded without the supposition that the vortex (presuming that there was only one in existence at this time) pursued a kind of zigzag course across its mean path. It is quite probable, however, that there may have been separate vortices at different places, if not in existence at the same times, at least formed in some irregular succession along a considerably wide belt of country. The data are not however sufficiently ample and reliable to distinguish between the different vortices which may have been formed. The storm as a whole seems to have been continuous.

The next place we hear of the central calm is at Digulgram, a village 12 miles N.N.W. from Jehanabad and 16 miles S.W. by S. from the town of Burdwan. Here the calm is said to have commenced between about 4 A.M., which time agrees very well with the general rate of progress of the vortex. I have not succeeded in identifying the place called "Akloky" on the map.

Of the passage of the storm over the town of Burdwan I have seen various accounts, all of which differed more or less in the time given for the commencement of the lull and also for its duration. It appears that before the lull the wind gradually decreased in violence until it was almost calm. That the calm continued for about three quarters of an hour, and that after this the wind again gradually increased until it reached nearly, but not quite, the same violence as before the lull. There thus seems to have been an interval of about a quarter of an hour before the calm, and the same interval after it had passed, in which the force of the wind was comparatively inconsiderable. This may, in some measure, account for the different estimates of time.

The following appears to be what took place:—On the night of the 15th the wind, from the N.E., gradually became more and more gusty, and by 1 A.M. was commencing to blow with considerable violence. By 3 A.M. the hurricane had reached its maximum strength, and the wind blew with unabated force up to about 5-30 A.M. From about this time it decreased to almost a calm between 5-30 and 6 A.M., and the calm continued until between 6-30 and 6-45, from which time the wind re-commenced to blow from the westward, and gradually increased in force, but never reached its violence before the lull. By 9 A.M. the wind had backed to S.W., and the storm was over at noon.

I visited Burdwan a few days after the cyclone and can bear out the Civil Surgeon's remark that all the large trees had fallen *from* N.E. and E. I also observed that the greatest destruction had occurred to trees where they grew very close together in the jungle and round villages. Few of the single trees in the open were blown down. These trees from long exposure to the weather

had apparently taken a firmer hold in the ground than those which were more or less protected from ordinary winds. Some tall trees, however, which were not blown down, were broken across, some in two or three places, and nothing remained standing but a few feet of the stump. Nearly all the trees which I examined were more or less injured by having branches broken off, and almost all were completely denuded of foliage.

The following series of observations were made by Assistant Surgeon Denobundoo Dutt from an aneroid. I have added a correction to the Calcutta standard obtained from the mean of 69 comparisons with the standard barometer at the Burdwan Observatory, whose error is accurately known. The readings as here given are equivalent to inches of mercury reduced to 32° F. The elevation above sea-level is approximately 102 feet.

Corrected aneroid readings.

2-12	A.M.	...	29·14	5-51	A.M.	...	28·44
4-15	„	...	28·86	6-30	„	...	28·51
4-25	„	...	28·83	6-48	„	...	28·56
4-35	„	...	28·81	6-58	„	...	28·64
4-42	„	...	28·71	7	„	...	28·71
4-46	„	...	28·68	7-21	„	...	28·83
4-49	„	...	28·63	7-35	„	...	28·94
4-50	„	...	28·61	7-50	„	...	29·01
4-55	„	...	28·59	8-15	„	...	29·10
4-56	„	...	28·54	8-35	„	...	29·25
5-5	„	...	28·49	9-2	„	...	29·30
5-30	„	...	28·46	9-15	„	...	29·38

To reduce these readings to sea-level an approximate correction of 0·1 may be added.

The lowest barometric reading recorded was 28·44, or reduced to sea-level 28·54, at 5-51 A.M., showing a depression of 1·36 inches below the normal atmospheric pressure.

Mr. Whinfield records three aneroid readings which he made during the passage of the cyclone. His aneroid has also been compared 69 times with the standard barometer at the Burdwan Observatory, and I have added the correction to the Calcutta standard. The corrected readings are—11 P.M., 29·47; 12 P.M., 29·35; 6 A.M., 28·48. The last reading may be compared with the readings given in the above table at 5-51 and 6-30. It will be seen that it lies between them. Mr. Whinfield remarks that the needle of his aneroid oscillated as much as two or three hundredths of an inch at every gust of the wind.

It will be observed that the lowest fall of the barometer recorded on board the *Coleroon* near the Sandheads, 27·58, was nearly one inch lower than the lowest reading at Burdwan. It is evident from the comparatively small loss of life and destruction of property in the Burdwan district that after passing the town of Midnapore the storm had greatly diminished in violence, and the vortex either became more erratic in its course or the successive vortices were more irregularly distributed.

A small Robinson's anemometer placed above the thermometer shed in the Civil Surgeon's compound was not injured by the cyclone. The reading at 4 P.M., of the 15th was 202·7. It was not read again until 4 P.M., of the 16th, and then marked 370·2. Assuming one complete revolution of 505 miles to have been completed in the interval, this would give 672·5 miles in 24 hours, or 28 miles an hour. This gives some idea of what the velocity of the wind, when greatest, must have been, as out of the 24 hours there were only about 8 or 10 during which the wind blew with violence.

The accident to the down passenger train near the Kanoo Junction, eight miles from the Burdwan station, affords a striking illustration of the power of the wind in the cyclone, even when the intensity of the storm had greatly moderated. The train which left Raneegunge at 11-15 P.M. should have arrived at the Kanoo Junction at 1-50 A.M. It had nearly a head wind from Raneegunge, which greatly impeded its progress, but it arrived at Mancoor

all right. Proceeding from this place to Kanoo the wind rapidly increased in force, and must at that time have been blowing from E. or E.N.E., the line running E.S.E. and W.N.W. The train was at last brought to a stand, within about a mile of the Kanoo Junction, by the force of the wind about 4 A.M. Kanoo was on the western side of the vortex, and the wind must at this time have been commencing to back rapidly from E.N.E. towards N. When the train, consisting of 25 carriages, was overturned, the wind had probably backed to N.N.E., from which point it would have been blowing directly across the line, and therefore with its full power on the sides of the carriages. I am informed by Mr. Broughton, District Traffic Superintendent, East Indian Railway, that a passenger, who was in one of the carriages which were upset, told him that the carriage was first lifted about six inches, and then dropped again; then higher a second time when it again dropped back; but that the third and strongest gust of wind lifted the carriage beyond its centre of gravity and it fell over. Three carriages standing on the line at the Burdwan station were also overturned by the force of the wind.

The following table shows the weights and dimension of some of the carriages which composed the train which was blown over near the Kanoo Junction. I have calculated the pressure in pounds per square foot which would be necessary to overturn each vehicle separately, supposing the pressure over the side to be uniform and perpendicular to the surface. The results are shown in the last column:—

Description of vehicle.	Height of the side of carriage.	Length of side of carriage.	Weight of carriage when empty.	Least overturning pressure on side in pounds per square foot.
			Tons Cwt. Qrs.	
6, 3rd class	8′ 7″	23′ 6″	9 11 0	34·1
1, 3rd „	8′ 7″	22′ 0″	8 0 0	37·0
1, Intermediate	8′ 5‴·5	20′ 0″	7 15 0	40·6
1, 2nd class	8′ 11″	20′ 0″	7 2 0	34·3
1, 1st „	9′ 11″	22′ 0″	8 6 0	36·5
1, B. Van	8′ 6″	20′ 6″	8 2 0	41·9
1, Wagon	7′ 7‴·5	16′ 6″	6 2 2	49·8
„	7′ 7‴·5	16′ 0″	5 2 3	39·3
„	7′ 8‴·5	16′ 0″	5 16 3	44·2
„	7′ 7‴·5	16′ 0″	6 4 0	47·8
„	7′ 8‴·5	16′ 0″	7 6 0	55·6
„	7′ 7‴·5	16′ 0″	5 17 3	45·1
„	7′ 7‴·5	16′ 0″	5 18 3	45·5
„	7′ 7‴·5	16′ 0″	6 4 0	47·8
1, Horse-box	7′ 7″	16′ 0″	5 0 0	38·6
1, B. Van	8′ 6″	16′ 0″	7 11 0	46·8

N.B.—Height from level of rail to sole bar of each carriage 3 feet. Distance between the wheels 5′·8″·5. All the carriages were overturned except the last two in the above list—the horse-box and brake-van.

The highest of the results shown in the above table, 55·6 pounds on the square foot, would correspond to a wind velocity of 105·5 miles an hour. It is to be observed, however, that as the carriages were connected with each other the overturning of the lighter vehicles (comparatively to area of exposed side) may have in some measure helped to upset those whose stability was greater. The rails at the place are about six feet above the level of the surrounding country, and the lifting force of the wind under the carriages, which has not been taken into consideration in the calculation, probably also helped to upset them. The least of the pressures, 34 pounds on the square foot, corresponding to a wind velocity of 82·5 miles an hour, may however, I think, be safely taken to represent the minimum force of the wind in the gusts which overturned the train. The mean of the overturning pressures is 42·8 pounds on the square foot, corresponding to a wind velocity of 92·5 miles an hour, for the vehicles which were upset. This estimate does not perhaps greatly exceed the probable force of the wind near the centre of one of these hurricanes on the western side. The greatest pressure registered in the Calcutta cyclone of 1864, before the anemometer at the Surveyor-General's office was broken, was 32 pounds on the square foot. But this was nearly two hours before the storm was at its height, and I am of opinion that the hurricane under report was more violent near its centre than that of 1864, although the area of destruction was much more limited. It is to be remarked that two of the

carriages were not overturned although the force of wind necessary to upset them was not greater than for some of the others. These carriages may have been in some way less exposed than the others, or they may have been more heavily laden. It has only been possible to take into account the weights of the vehicles when empty in the calculation. However, it has frequently been remarked how capricious the gusts appear to be in cyclones, neighbouring structures, equally exposed, often suffering in very different degrees.

From Jehanabad to Burdwan, the distance over which the vortex travelled in about 24 hours 40 minutes, is 28 miles, which would give a mean rate of motion of 10½ miles an hour. If we suppose that the centre passed directly over Burdwan, and that the calm lasted for about an hour, preceded and followed by a partial lull of quarter of an hour, the longitudinal diameter of the vortex at this time would have been 10 miles surrounded by a comparatively calm ring 2½ miles in breadth.

From Arooar, 15 miles north of Burdwan, we next hear of a lull in the middle of the storm. The Inspecting Medical Officer of the Munglecote Circle, writing to the Civil Surgeon, says:—

During the early part of the night of the 15th October the wind blew from the direction of east having a slight inclination to the north. The wind gradually increased as the night advanced: heavy rain accompanied it. The cyclone was at its height between about 3 and 5 A.M., when the direction of the wind was due N.E. Very heavy rain fell during these hours. From about 5 A.M. on the 16th the wind began to get mild, and from 5½ or 6 to 7 there was a lull, not a calm. The wind, though very mild, was apparently irregular and gusty. At this time the heavy rain which had accompanied the cyclone very nearly ceased. From 7, or a little after, the wind began to blow from due W., at first mildly, but it gradually increased in violence, and there was an increase of rainfall also; but neither the wind was so violent nor the rain so heavy, as they were before the lull. After 10 the rain almost ceased, but the wind, though it gradually got milder and milder, kept on blowing direct from the W., until at about 12 or 1, when the sky became clear and the atmosphere tranquil.

It will be observed that the times given for the commencement and end of the lull at Arooar are exactly the same as for Burdwan, and the above account, which I do not think can be relied upon as regards time, seems to have been framed on the model of some of the Burdwan narratives, possibly with the view to render it consistent with them in its leading facts. The only conclusion I wish to draw from the account is that there was a lull or partial lull at Arooar. This is consistent with other data.

The sub-divisional officer of Bood-bood, it will have been seen, reported that there was a calm or lull at that place, commencing at 5-30 A.M. and lasting for quarter of an hour. Assuming that the statement about the lull at Bood-bood is accurate, there appear to be reasons for doubting that it was due to the passage of any separate vortex near that place. Bood-bood is 24 miles W.N.W. from Burdwan and close to the railway station of Mancoor, beyond which it is known from other sources of information that the violent part of the storm did not extend. It appears also from the remarks of the Magistrate of the district that in Bood-Bood the damage done by the storm was less than elsewhere, and it was only the eastern part of the sub-division which suffered at all considerably. Moreover, the sub-divisional officer's account of the wind directions is altogether inconsistent with the supposition of a lull at Bood-bood in the middle of the storm in any way resembling the calms recorded at other places. He says that the wind which commenced on the night of the 15th to blow with force from N.E. was strongest at N.W. up to 5-30, and that after the lull it again re-commenced to blow from the same quarter, N.W. Again, writing in reply to enquiries from the Civil Surgeon, he says that the wind was strongest from the N.W.; that it was again N.W. after the lull, and finished at N.! It appears to me improbable that there was any complete lull at Bood-bood in the middle of the storm, although there may have been, as at Calcutta, a temporary decrease in the force of the wind.

East of the vortex.—All accounts agree that the violence of the cyclone did not extend far beyond Pundooah, a station on the East Indian Railway, 28 miles

E.S.E. from Burdwan. From my own observations, when travelling up the line to Burdwan a few days after the storm, I would say that the belt on the eastern side of the path of the centre over which the destructive part of the cyclone extended was not more than about 25 miles in breadth. Near Boinchee, a station 23 miles from Burdwan, the effects of the hurricane first became strongly marked; but from this into Burdwan the tokens of devastation rapidly became more numerous and significant.

The sub-divisional station of Culna is about 30 miles due E. of Burdwan. From the account of the Deputy Collector it appears that at this place the wind was never stronger than a heavy gale, and little damage was done.

The sub-divisional station of Cutwa is about 33 miles N.E. by N. from Burdwan. The centre of the vortex must have passed at no great distance to the W. of this place. The greatest violence of the storm was between 8-35 and 10-45 A.M., when the wind was S.E. The cyclonic intensity of the storm had, however, by this time greatly diminished; and although the vortex passed through this sub-division, there was comparatively little loss of life or destruction of property.

The following account of the gale which extended into the Nuddea district during the passage of the cyclone, is taken from a report by the Collector, Mr. C. C. Stevens, to the Government of Bengal:—

The storm commenced at the sudder station on Thursday, the 15th October, at 7 o'clock P.M. The wind then was blowing from E.N.E. It gradually veered round to the S.E., blowing in gusts with increasing force till about 7 A.M. of Friday, 16th October. From that time it began to diminish in violence, but continued to veer round to S., and subsequently to W. The weather became calm again by sunset. The rain fell chiefly on Thursday night. Many branches of trees (some of considerable size) were broken, but only two or three of the numerous teak trees in the station have been uprooted. In the directions of Kooshtea, Chooadangah, and Bongong the effects of the cyclone have been hardly felt. The wind was a little higher than usual, with hardly perceptible gusts. At Ranaghat it was a little severer; a few plantain trees were thrown down here and there.

The cyclone was, however, the severest in the north-west parts of the district. The real storm commenced at about 3 P.M. of the 15th, and continued all night, accompanied with heavy rain. The wind was blowing throughout the night from E. On the morning of the 16th October the wind veered to the S. and commenced decreasing in violence. By 6 o'clock P.M. the storm had altogether subsided. The wind was then blowing from S. to W. At the head-quarters of the sub-divisional station of Meherpore the total quantity of rain which fell during the night of the 15th October was by measurement found to be 2·39 inches. I am glad to be able to say that there has been very little loss of life. Only four cases within the local jurisdiction of thana Kaligunge have come to my knowledge.

No systematical barometrical readings appear to have been taken anywhere except in Saroopgunge, and I annex a copy of the figures taken by the toll collector, Mr. F. Y. Cornish:—

	10 A.M. Mercurial Barometer.	4 P.M. Mercurial Barometer.	Wind.	Thermometer.
14th October ...	29·73	29·63	N.N.E. and N.E.	87
15th „ ...	29·72	29·67	N.N.E.	87

Mercurial barometer at 10 P.M ... ... 29·65
Aneroid at 10 P.M. ... ... 29·73

Wind got up during the night, veering to E. and E.S.E.

BAROMETER READINGS.

Hour.	Mercurial.	Aneroid.	Thermometer.	Wind.	Remarks.
A.M.					
4	29·46	29·48	81	E.S.E.	Blowing hard and wind increasing steadily.
5	·42	·45	.....	.....	
6	·40	·43	.....	.....	
6-30	·35	·40	.....	.....	
7	·34	·40	.....	.....	
7-30	·33	·38	.....	.....	
8	·34	·41	.....	.....	

BAROMETER READINGS.—(*Continued.*)

Hour.	Mercurial.	Aneroid.	Thermometer.	Wind.	Remarks.
A.M.					
8-30	·35	·43	.....	S.E. and S.	During these three hours the storm at its height blowing at times in fearful gusts. Raining heavily.
9	·36	·47	.....	.....	
9-30	·36	·48	78	.....	
10	·37	·50	.....	S.	
10-30	·38	·51	.....	.....	
11	·40	·52	79	S. by W.	
11-30	·40	·52	.....	.....	
12	·42	·53			
12-30	·43	·54			
P.M.			.....	S. by W. and S.S.W. ...	Wind commenced to decrease gradually, but still blowing very stiff and in gusts.
1	·45	·55			
1-30	·50	·57			
2	·50	·57			
2-30	·51	·58	.....	S.W.	Blowing a moderate gale.
3	·51	·60	.....	.....	
3-30	·51	·61	.....	.....	
4	·52	·62	.....	W.S.W. and W. ...	
4-30	·54	·63			
5	·55	·64	.....	N.W.	Wind almost ceased.
6	·56	·66			
9	·63	·73			

Fall of rain, during storm, three inches.

It will be seen from the above that no loss of life was recorded in the Nuddea district except in the thana of Kaligunge. The police station of Kaligunge is on the Bhagiruthee about eight miles north-east from Cutwa and is not further than 12 miles from the nearest point of the mean path of the centre of the storm. The whole thana was well within the eastern belt of the cyclone, which however, before reaching this latitude, had greatly diminished in violence.

The barometric readings given by Mr. Cornish are not reduced or corrected. His mercurial barometer appears to read at least one-tenth of an inch too low. Saroopgunge, where the observations were made, is close to the town of Nuddea, and about 28 miles from the mean path of the centre of the storm. The lowest fall of the barometer was at 7-30, or a little more than an hour and a half later than the lowest reading at Burdwan. A rate of 10 miles an hour from Burdwan would place the centre of the storm W.½N. from Nuddea at the time, and 18 miles further along its course would bring it nearest to Cutwa. This would give about 9-20 A.M. as the time when the storm was nearest to Cutwa, and agrees very closely with the estimate made by the Deputy Collector of that place.

The comparative loss of life on the eastern and western sides of the storm in the Burdwan district may be seen by the following arrangement of thanas from S. to N.:—

Intersected by vortex.

Goghat	...	...	...	...	...	14
Khundghose	...	...	...	...	...	10
Burdwan	...	...	...	...	...	6
Sahebgunge	...	...	...	...	...	3
				Total	...	33

West of vortex.

Kotulpore	...	...	27
Indus ...	...	...	11
Bood-bood	...	...	16
	Total	...	54

East of vortex.

Jehanabad	...	...	9
Selimabad	...	...	2
Cutwa ...	...	...	1
	Total	...	12

The law pointed out by Mr. Harrison that the violence of the wind is greatest on the western side of the vortex, next at the vortex, and least E. of

it, is clearly shown by the above arrangement to have been true in the Burdwan district as well as in that of Midnapore, if the violence of the wind may be judged of by the comparative loss of life. It will also be seen from the above that the mortality in the southern parts of the district was very much heavier than in the northern parts.

West of the Vortex.—The Inspecting Medical Officer of the Jehanabad Circle states that the storm was continuous at Buddungunge, 15 miles due W. from Jehanabad, and at Indus, 18 miles W.S.W.½S. from Burdwan. Along the East Indian Railway the violent part of the hurricane does not appear to have extended much beyond Mancoor, 23 miles from Burdwan, and not as far as Pannaghur, seven miles further.

Bankoora, about 50 miles due W. from Burdwan, was but slightly affected by the storm. It is remarkable that the wind was strongest about midnight of the 15th from N., three or four hours before the nearest approach of the cyclone. The Collector, Mr. Larminie, writes:—

The 15th of October was gusty and showery, the wind blowing from N. and N.E. About 10 P.M. the wind increased in violence, and continued to blow hard till about 4 A.M. of the 16th from the N. and N.W. Its greatest violence was felt about midnight. The damage was slight. A few trees were blown down.

From Assensole on the East Indian Railway, 65 miles from Burdwan, Dr. Roberts writes:—

The wind blew strongly from N.E. on the 15th, and during the night increased in strength, accompanied by rain. But at no time was the wind violent enough to do any damage to huts or trees or anything else. The wind varied from N.N.E. to E. by N. during the night, but was at no time S. of E. or W. of N. during the gale, which abated early on the morning of the 16th.

Here, as at Bankoora, the strong wind which preceded the cyclone had subsided before the vortex was nearest.

The following extract of a letter from Dr. R. A. Barker, Civil Surgeon of Soory, to the Deputy Surgeon-General, is an account of the storm as felt at that place:—

On the 16th instant a severe cyclone passed through the district. On the evening of the 15th the sky was overcast and numerous black clouds were flying past the station at a greater speed than the wind blew, which was N.E., with drizzling rain. During the early part of the night the wind increased and was blowing a hard gale by 4 A.M. of the 16th. The total quantity of rain that fell during the night was 2·31. The wind at 6 A.M. was blowing from the N. in fitful gusts of great strength, and seemed to be at its height about 7 A.M., when numerous branches of trees were wrenched off, and a few were blown down. About 8 A.M. there was a lull for half an hour, after which the wind shifted to N.N.W. and blew with terrific force, destroying many houses and blowing down over 100 fine large trees in the station. At 11½ A.M. the wind was N.W. and its force considerably diminished, and gradually decreased to a gentle breeze. The total fall of rain from 6 A.M. to 11½ A.M. was 2·38. The following are the barometrical readings (not reduced):—

Date.	Hour.	Barometer.	Wind.
15th	10 A.M.	29·58	N.E.
„	4 P.M.	29·54	N.E.
16th	6 A.M.	29·34	
„	8 „	29·28	
„	9 „	29·28	
„	10 „	29·26	N.W.
„	10-30 „	29·26	
„	11 „	29·24	
„	11-30 „	29·26	
„	4 P.M.	29·36	N.W.

The elevation above sea-level is given as 233 feet. Nothing is known, however, about the barometer from which the readings were taken. I imagine it is an aneroid, as the column for the temperature of the mercury is not filled up in the Soory meteorological register furnished by the civil surgeon. The lull of half an hour from 8 A.M., mentioned above, appears to have been only a temporary decrease in the force of the wind, and not a true lull due to the near approach of any vortex, as it is stated that the wind which was N. before the

lull, only shifted to N.N.W. after the lull was over.* Soory is about 35 miles from the nearest point of the mean path of the vortex, which passed over Burdwan, and there is no evidence to show that a secondary vortex passed over Bood-bood and Soory. The western limit of the cyclone does not seem to be as clearly definable in the Burdwan district as in Balasore and Midnapore. However, the data for the Burdwan district are not nearly so full as those for Midnapore. A remark made by Mr. Whinfield in his report "that the storm had not been felt at Illam Bazar," about 20 miles south of Soory, and 16 miles north of Bood-bood, would show that the storm was not continuous between those places, if the account which he heard can be relied on. The Collector of Beerbhoom has not reported any loss of life or damage to property, in his district, resulting from the gale.

Moorshedabad District.

The following statistics of the storm in the Moorshedabad district are taken from the report of the Collector, Mr. Wavell:—

I proceed to give an abstract of the reports with regard to the direction and force of the wind and other particulars of interest that I have received from various parts of the district and from Gonateea in Beerbhoom, commencing with Ramnuggur, which is nearly the southernmost place in the district:—

Ramnuggur.—Wind commenced from N. on the evening of 15th and continued, gradually increasing, till 5 A.M. of the 16th, when it turned into a gale, during which time it worked round to the N.E.; and as the morning advanced the wind increased, working round to the S.E. between 9 and 10, when it was at its height, and most destruction was then done. After this the wind, gradually decreasing, moved round to W.S.W.

Gonateea.—Thursday, October 15th.—Blowing from the E.; increased towards evening; strong gale during the night. Friday, the 16th, 6 A.M.—Blowing hard from the N.E. with very heavy rain; gradually veered to the N. about 9 A.M. (the wind was at its height at about 10 A.M.) till 12-30 P.M.; then a lull, and the wind went round to the N.W. still blowing hard, but not so hard as before, and the rain ceased.

Gouripore, almost due E. of Gonateea in thana Bhurtpore, on the Bhagiruthee.—Storm commenced about 5 P.M. on the 15th, the wind being from N.N.W. veering round to N.; rain and strong wind all night. Storm at its height from 5 A.M. on the 16th to noon, the directions of the wind being at 5 A.M. N., at 7 A.M. N.E., 8 A.M. N.E, noon S.E., 1 P.M. S.

Putkabaree, almost due E. of Gouripore, close to the Jellinghee.—Thursday, the 15th.—High wind, with showers during the day, increasing in the evening. On the morning of the 16th, before dawn, blowing hard from N.E., shifting to E. by N. by daybreak. At about 8 A.M. wind veered round to the S., blowing almost a hurricane, with heavy rain for about 3½ hours when the storm appeared to be at its height. Moderated at midday, the wind gradually going round to the W.

Beldanga, thana Burwa, about 16 miles W.N.W. of Putkabaree.—Storm commenced at about 6 A.M. on the 16th, increasing until about 9-30 A.M., from which time up to about 11 o'clock it was at its height, the wind then being from the E. There was then a lull till about 3 P.M., when the storm recommenced and lasted till about 5 P.M. The direction of the wind during this period is not stated. It is probable that the time at which the storm was at its height was somewhat later than is stated by my correspondent. The centre of the storm evidently passed over this place.

Kandi, about 14 miles W. by N. of Beldanga, and about the same distance N.E. of Gonateea.—Strong easterly wind during the night of the 15th and 16th, increasing in violence till it was at its height at about 9-15 A.M. Lull at about 11-30 for an hour, when the storm recommenced with greater force, the wind being from the N.N.W., veering occasionally towards the E. The wind appears to have been at its height between 12 and 1 P.M., *i.e.*, rather more than two hours later than at Gonateea. The storm lasted till 4-40 P.M., when the wind dropped and the rain ceased.

Rungamuttee about 12 miles N.E. of Kandi.—October 15th.—From 9 A.M. the wind was blowing from the S.E. in fitful gusts with rain till the evening, when it gradually veered round to the E., from which direction it was blowing at 3 A.M., with heavy rain. At 5 A.M. the wind was blowing strong from the N.E. till 9 A.M., when it began to veer to the S.E., being at its height at about noon. From that time till 1 P.M. there was a dead calm, after which the wind commenced again blowing from the N.W. and gradually died away by 6 P.M. in a south-westerly direction.

* Since writing the above I have heard from Dr. Barker that the lull at Soory (about which, as well as that reported at Bood-bood, I was at first somewhat incredulous) was observed and noted by himself. He says, however, that "there was no calm, but the force of the wind considerably abated and was reduced to what might be called a *fresh breeze*."—W. G. W.

Choa, about 18 *miles E. of Rungamuttee.*—October the 15th.—Wind blowing from the E. with rain. October 16th.—Strong gale from the E. with very heavy rain. 10 A.M.—Blowing from the S.E. with heavy rain. 11 A.M.—Rain ceased; storm at its height. 1 P.M.—Wind much abated, blowing from S.S.E.; calm at 1-15 P.M. Wind recommenced at 2 P.M., blowing from the S. and S.W. 3 P.M.—Wind abated with slight showers. 5 P.M.—Sky clearing.

Berhampore.—October 16th.—Wind blowing in strong gusts from the E. 8-30.—Terrific gusts from the N. and N.E. 11-30.—Strong gale from the N.E. 1 P.M.—Storm at its height, wind blowing from the S.E. 1-15.—Wind calm from the S.; lull till 3-15, when wind recommenced blowing strong from the N.W.; died away at 5-30 P.M., having veered round to the N.W.

Rampore Haut.—October 16th.—Wind in the morning from the N.E., shifting to N.N.E., the storm being at its height at about 11 A.M.

Dumkoh, 20 *miles E. by N. of Berhampore.*—October 16th, 6 A.M.—Squally, with showers of rain from the N.E., veering round to S.S.E. Storm at its height between 2 and 3 P.M. The wind blew from that quarter till about 9 P.M., when it lulled.

Moorshedabad City.—October 16th.—Storm commenced about 8 A.M., wind blowing from the E.S.E., increasing in violence until about noon, when there was a lull till 1-30 P.M., when the wind recommenced with greater violence, blowing from the N.W. till 5 P.M., when there was a lasting calm.

Azimgunge, seven miles N. of Moorshedabad.—Strong gale from the E. at 1 A.M. on the 16th, continuing till 1-30 P.M., when there was a lull for half an hour. About 2 P.M. storm recommenced from the opposite direction and lasted for two hours.

Sagurdighi, on the Nulhattee State Railway, at which I was encamped during the cyclone.—During the afternoon of the 15th, strong wind, with heavy rain, blew from the E., increasing in vehemence during the night. The wind gradually veered round to the N., and the storm was at its height between 12 and 2 P.M., when the wind blew from a point a little E. of N. A stiff gale continued with rain till the evening, when wind and rain gradually subsided, wind working round to the S.

Akrigunge, N.E. of Berhampore, about 23 *miles distant.*—October 15th, 10-12 A.M.—Wind from the S.E., with drizzling rain. Wind and rain increased in violence during the rest of the day and the following night. October 16th, 10-12 A.M.—A hurricane, with heavy rain; wind S.E. by E. 12-30 to 2 P.M., calm, with wild sky. 2-30 P.M.—Strong wind from N.E.; storm at its height. 4 P.M.—Wind N., but working round to the W., and decreasing in force. 5 P.M.—Wind blowing from the S.

Rajarampore, 22 *miles N. by W. of Berhampore.*—On the afternoon of the 15th easterly wind with heavy rain. Storm commenced at 8 A.M. on the 16th, and was at its height about 1 P.M., when the wind was blowing due N. The storm ended at 4 P.M., when the wind was blowing from the N.N.W. The gentleman who has given me information with regard to this place was not at his factory at the time, and it is therefore probable that there has been some mistake as to the hour at which the storm was at its height; for, judging from the personal observations at other places south of Rajarampore, the storm could not have been at its height at so early an hour.

Lalgolah, eight miles N.E. of Rajarampore.—Storm commenced about 4 A.M. on the 16th, attended with very heavy rain; no less than 16·30 inches having fallen from 6 P.M. on the 15th to 6 P.M. on the 16th, according to the Assistant Surgeon's observation. He states that the wind remained at an almost uniform force between the hours of 11-30 A.M. and 3 P.M., the weather being almost clear at 5 P.M., the wind blowing from a point a little E. of N. Many trees and very many houses were blown down at this place.

Jungipore.—From the night of the 15th to about 10 A.M. on the 16th wind blew from the E., and then commenced to blow from the N., the storm being at its height between 2 and 3 P.M., when the wind blew from the N.E. Very heavy rain fell throughout, and there was no lull.

At Noorpore, about seven miles N. of Jungipore, the phases of the storm appear to have been the same as at the latter place, but no precise details are given.

At Dhulian, on the Ganges, 16 *miles N. of Jungipore,* there was only a moderate gale. Mr. Lyon states that on the afternoon of the 15th it blew freshly from the E. On the morning of the 16th it blew from N.E., gradually veering round to N., and that he conjectured that they were, at Dhulian, on the N.W. and W. outer edge of a cyclone. There was apparently no increase in the force of the gale, which lasted till about 3 P.M., when it began to abate, and the evening was quiet, with slight breezes from the W. The barometer marked 29·70 at 10-30 A.M., 29·61 at 12-30 P.M., and 29·46 at 3-30 P.M., when it began to rise again. Only $2\frac{3}{4}$ inches of rain fell during the two days.

From the observations made at these places, it would appear that the cyclone passed almost throughout the length and breadth of the district, the central portions of which were passed over by the centre of the storm, as shown by the lulls at Kandi, Beldanga, Choa,

Berhampore, Moorshedabad, Azimgunge, and Akrigunge. I have been unable to obtain observations from many places in the N.W. of the district, and the report from Rampore Haut is meagre; but from information that I have been able to obtain, it seems that the cyclone passed through all but the most northerly portion (Dhulian and its vicinity having escaped), and, crossing the Ganges, passed though the district of Rajshahye. The escape of this northern part of the district was probably due to the easterly inclination of the storm, which inclination may, I think, be safely assumed from its course after impinging on the mainland in the Midnapore district.

The effects of the cyclone were noticeable in the destruction of human life, of cattle, and the sinking of boats and destruction of houses, and in the injury caused to the mulberry, sugarcane, til, and chilli crops, and to the advanced portion of the winter rice-crop; while the backward portion and the late transplantations were very greatly benefitted by the heavy rain. The loss of human life reported amounts to 27; but this number is probably under the mark, as some deaths by drowning and in other ways were, I imagine, not reported to, or ascertained by, the police. Ninety-five head of cattle are said to have been destroyed, and this number also is probably somewhat under the mark. No information on which any reliance can be placed has been obtained as to the number of houses partially or totally destroyed; but as far as my observations in many parts of the district have gone, the damage has been chiefly confined to old thatched houses, which have been unroofed, or the mud walls of which have fallen. The til crop has, I believe, been more damaged than any other; and in the case of this crop the loss has doubtless been somewhat considerable. In the case of the mulberry crop, the heavy rain has been productive of injury, as the shoots that have been produced since its fall have proved to be very unwholesome for the worms and have caused the death of a great many. As to the rice-crops, I am now satisfied beyond doubt that the damage done to the advanced portion is as nothing compared to the benefit caused to the late transplantations. In many parts of the district late transplantations formed the bulk of the crop, and it is not too much to say that, had there not been heavy rain in October, they would have yielded little or nothing.

On the whole, therefore, although the loss of human life, the damage caused to houses and other property and to the minor crops, is to be regretted, especially during a year of such scarcity and pressure, the great benefit caused to a considerable part of the most important crop of the year must not be forgotten in estimating the effects of the late cyclone.

Phases of the storm in the Moorshedabad District.—Ramnugger is 11 miles N.E. by N. from Cutwa in Burdwan, and the account of the veering of the wind at this place agrees tolerably well with the presumed general course of a cyclonic vortex moving from the town of Burdwan towards Berhampore. However, supposing the vortex to have been nearest to Cutwa about 9-30 A.M., it would be expected that the wind at Ramnugger would not have gone round to S.E. before about 11 o'clock; whereas it is stated to have been blowing from that point at its strongest between 9 and 10 A.M. At Gouripore, four or five miles N.N.W. from Ramnugger, it is stated that the wind was N.E. at 8 A.M., S.E. at noon, and S. at 1 P.M. So far, then, it would appear safe to conclude that the account from Ramnugger is incorrect as regards time, as it is unlikely that the phases of the storm at that place were more than an hour in advance of those at Gouripore, which latter are consistent with the general supposed progress of the Burdwan vortex. At Putkabaree, 17 miles E. by N. from Gouripore, it is stated that the wind had veered from N.E. to E. by daybreak, and by 8 A.M. was blowing almost a hurricane from S., when the wind was N.E. at Gouripore, and that the storm was over by noon, the wind having gone round to the W. It is also to be observed that in the early morning the wind at Gouripore was N., a direction hardly consistent with the supposition that the wind at that time was blowing towards the Burdwan vortex.

It will be seen from the above examples that, if the data can be regarded as even approximatly correct, the supposition of one continuous vortex progressing from Burdwan to Berhampore will not explain the different phases of the storm as observed at different places in the Moorshedabad district. This will appear in a stronger light when the times of the lulls in the middle of the storm, as recorded at different places, are considered.

From the town of Berhampore I have got two series of observations, which appear to be accurate and consistent with each other. One set were made at the Government Meteorological Observatory; the other set were taken by Mr. Stocks

at Baboolbonah, close to the town. It will be convenient first to consider the phases of the storm at Berhampore, which may serve, in some measure, as guides in tracing what happened at neighbouring places. The two series of observations referred to are given below. The barometric readings made at the observatory are reduced for temperature and corrected to the Calcutta standard.

Observations taken at the Berhampore Meteorological Observatory.

October 1874.	Hour.	Barometer reduced to 32° F.	Hygrometer.		Wind.		Rain.	Cloud-covered sky.
			Dry.	Wet.	Velocity.*	Direction.		
15th	10	29·792	81	79	.....	E.	0·49	10
„	16	·699	78	76	7	E.N.E.	.....	10
16th	5	·559	77	76·5	11	N.E.	.....	10
.....	5-30	·660	.....	.....	.....	N.E.	.....	.....
.....	6	·570	77	76	.....	N.E.	Heavy	10
.....	6-30	·553	.....	.....	.....	N.E.	„	.....
.....	7	·529	77	76	14·5	N.E.	„	10
.....	7-30	·535	.....	.....	.....	N.E.	„	.....
.....	8	·515	77	76	21·6	N.E.	„	10
.....	8-30	·519	.....	.....	.....	N.E.	„	.....
.....	9	·491	78	77	.....	N.E.	3·20	10
.....	9-30	·461	.....	.....	.....	N.E.	.....	.....
.....	9-45	·459	.....	.....	.....	N.E.	.....	.....
.....	10	·451	78	77	24·7	N.E.	.....	10
.....	10-30	·415	.....	.....	.....	N.E.	.....	.....
.....	10-45	·379	.....	.....	.....	N.E.	.....	10
.....	11	·357	.....	.....	.....	N.E.	.....	.....
.....	11-15	·339	.....	.....	.....	N.E.	.....	10
.....	11-30	·298	.....	.....	.....	N.E.	.....	.....
.....	11-45	·268	.....	.....	.....	N.E.	No rain	10
.....	12	·202	76·5	75	33·5	E.	„	10
.....	12-15	·123	.....	.....	.....	S.E.	„	.....
.....	12-30	·050	.....	.....	.....	S.E.	„	.....
.....	12-45	28·996	.....	.....	.....	S.S.E.	„	.....
.....	13	·971	78	76·5	†30·0 ?	S.S.E.	„	8
.....	13-15	·967	.....	.....	.....	S.S.E.	„	.....
.....	13-30	·981	.....	.....	.....	S.W.	„	6
.....	13-45	·997	.....	.....	.....	S.W.	„	10
.....	14	29·023	78	77	.....	W.	.....	10
.....	14-15	·153	.....	.....	.....	N.W.	Drops of rain	.....
.....	14-30	·075	.....	.....	.....	W.	„	.....
.....	14-45	·193	.....	.....	.....	N.W.	„	.....
.....	15	·186	77	75	.....	N.W.	„	10
.....	15-15	·248	.....	.....	.....	N.W.	„	.....
.....	15-30	·313	.....	.....	.....	N.W.	„	.....
.....	15-45	·365	.....	.....	.....	N.W.	„	.....
.....	16	·393	76	75	.....	N.W.	Heavy	10
.....	16-15	·416	.....	.....	.....	N.W.	„	10
.....	16-30	·455	.....	.....	.....	N.W.	„	.....
.....	16-45	·475	.....	.....	.....	N.W.	„	.....
.....	17	·501	74·5	73 5	.....	N.W.	„	10
.....	17-15	·517	.....	.....	.....	N.W.	„	.....
.....	17-30	·537	.....	.....	.....	N.W.	.....	.....
.....	17-45	·553	.....	.....	.....	N.W.	.....	.....
.....	18	·565	74	73	.....	N.W.	2·73	10
.....	18-15	·582	.....	.....	.....	N.W.	.....	.....
.....	18-30	·585	.....	.....	.....	N.W.	.....	.....
.....	18-45	·595	.....	.....	.....	N.W.	.....	.....
.....	19	·603	.....	.....	.....	N.W.	.....	10
.....	19-30	·615	.....	.....	.....	N.W.	.....	.....

* Shows the mean velocity of wind in miles per hour since last observation.

† Anemometer broken when this reading was taken, so that the velocity shown is probably much too small.

Barometric readings taken at Baboolbonah on 16th October 1874 by Mr. J. W. Stocks.

Hour.	Barometer.	Wind.	Rain.
7	29·680	Blowing strong in gusts, E.	Very heavy.
7-30	·660	Gale increasing from N.E.	Very dark and heavy rain.
8	·630	Strong gusts from N.E. and E.	Not so heavy and clearer above.
8-30	·630	Terrific gusts from N. and N.E.	Heavy rain, dark clouds, 8.
9	·620	Ditto ditto increasing ditto	Very heavy.
9-30	·570	Terrible gusts blowing, N.E.	Heavier than ever; compound on sheet of water.
10	·570	Ditto ditto ditto	Less rain.
10-30	·540	Storm as bad as ever; blowing from all sides, principally E.	Heavy rain falling.
11	·500	Ditto ditto ditto ditto ...	Ditto ditto.
11-30	·430	Most terrific gusts, N.E.	Ditto ditto.
12	·340	Hurricane blowing, N.E.	No rain.

Barometric readings taken at Baboolbonah on 16th October 1874 by Mr. J. W. Stocks.—(Contd.)

Hour.	Barometer.	Wind.	Rain.
12-15	·270	Hurricane blowing, S.E.	No rain.
12-30	·210	Ditto ditto E. and S.E.	Ditto.
12-45	·140	Stronger than ever ditto	Ditto.
1	·100	Ditto ditto ditto	Cleared up.
1-15	·090	Wind calm, S.	
1-30	·080	A fine calm day, S.	Sunshine.
1-45	·100	Ditto ditto	Heavy clouds, N.
2-15	·110	Clouds gathering, W....	
2-30	·130	Ditto ditto	
3-15	·240	Blowing strong from N.W.	
4	·440	Ditto ditto	Rain falling.
4-30	·520	Ditto ditto	Heavy rain.
5-30	·620	Little wind from N.W.	Slight rain.
6-15	·670	Ditto ditto	Clouds drifting S.E.

At 4 P.M. of the 15th the barometer at Berhampore was 0·016 higher than at the same hour of the previous day. The wind during the day was light from E. and E.N.E.; the mean velocity between 10 A.M. and 4 P.M. being only seven miles an hour. The sky was, however, overcast, and half an inch of rain had fallen since the preceding day. About 7 o'clock in the morning of the 16th the wind, which had backed round to the N.E., was beginning to blow strong in the gusts. The mean velocity from 5 A.M. to 7 A.M. was, however, only 14·5 miles an hour. From 7 A.M. to 8 A.M. the velocity increased to 21·6 miles an hour, and the barometer about this time was commencing to fall rapidly. The wind appears from Mr. Stock's observations to have varied considerably in the gusts, but N.E. seems to have been the prevailing direction up to 11-45 A.M. Up to this hour there was very heavy rain, but it ceased when the wind commenced to veer rapidly to E. and S.E. Between 10 and 12 the mean velocity of the wind was 33·5 miles an hour. This would only correspond to a pressure of 6·25 pounds on the square foot, but the force of the wind in the gusts was probably at least twice as great as this. Some time between 12 and 1 P.M. the anemometer was broken. When read at 1 P.M. it showed an increase of 30 miles. The wind appears to have been strongest between 12 and 1 P.M., as it veered rapidly from E. to S.S.E. During this time, however, it is remarkable that there was no rain. From 1 P.M. the force of the wind gradually decreased, and it was calm by 1-15. At this time the lowest reading of the barometer was recorded at the Observatory 28·967, or 29·033 reduced to sea-level. The lowest reading recorded by Mr. Stocks was quarter of an hour later. During the calm, which lasted until 3 P.M., or for an hour and three-quarters, the clouds partially cleared away and the sun became visible.

Up to 11-45 the N.E. direction of the wind would indicate that a cyclonic vortex was moving slowly towards Berhampore from S.S.E. But from this hour until the lull commenced the wind veered with extraordinary rapidity from N.E. to S.S.E.; and after the lull recommenced to blow nearly from the opposite quarter, N.W. The directions of the wind before and after the lull would indicate that the vortex passed over Berhampore, moving from about W.S.W. or W. to E.N.E.

One or other of three suppositions would account for these changes of the wind—(1) That the N.E. current from 5 A.M. to 11-45 A.M. was not the immediate effect of any one particular vortex, but was caused by the general atmospheric depression to the southward, which probably extended over a very considerable area from W. to E. (2) that the N.E. current was produced by a vortex advancing towards Berhampore from S.S.E., but that the vortex when very near to that place suddenly turned towards the westward and again returned towards the E. or E.N.E. as it passed over Berhampore. (3) That, as in (2), the N.E. current was produced by a vortex coming up from S.S.E., but that this vortex broke up and was succeeded by a second vortex advancing on Berhampore from W.S.W.

After the lull the wind does not appear to have blown with any great strength, but its direction continued constant from N.W. By 5-30 P.M. the wind had died away. From this alone, and the comparatively small fall of the barometer, considering that the centre must have passed almost directly over Berhampore, it would appear that the vortex was not one of any great cyclonic intensity, that it was moving very slowly, and that it probably broke up shortly after passing Berhampore.

I shall now consider the various places around Berhampore where it is reported that lulls, in the middle of the storm, of different durations, and commencing at different times, occurred, and see if any of the vortices which passed over these places can be identified with that which passed over Berhampore.

The following tabular statement will assist in this investigation :—

Name of place at which lull is reported to have occurred.	Bearing of place from Berhampore.	Distance of place from Berhampore.	Reported time when the lull commenced.	Reported time when the lull ended.	Direction of wind immediately before the lull.	Direction of wind immediately after the lull.	Remarks.
Soory	W.S.W.	46	8	8-30	N.	N.N.W.	Before lull wind backed from N.E. to N., after lull it further backed to N.W.
Gonateea	W.S.W.$\frac{1}{2}$S.	31	12-30 ?	?	N.	N.W.	Not very clear when lull commenced. May have been after 10 A.M. Before the lull the wind backed from N.E. to N.
Kandi	S.W. by W.	16	11-30	12-30	?	N.N.W.	Direction of wind before the lull not stated. Changes not clearly shown.
Rungamuttee ...	S.W. by S.	7	12	1	S.E.	N.W.	Same changes of wind as at Berhampore.
Beldanga	S.	12	11	3	E.	?	Changes of wind not stated.
Choa	E.S.E.	14	1	2	S.S.E.	S.S.W.	Wind veered from E. to S.S.E. before lull.
Rampore Beauleah	N.E. by E.	29	2	4	S.S.E.	W. by S.	Before the lull the wind veered from E. by N. to S.S.E. After lull it veered from W. by S. to N.W.
Akregunge ...	N.E.$\frac{1}{2}$N.	19	12-30	2	S.E. by E.	N.E. ?	Changes of wind before lull not stated. After lull it backed from N.E. through N. to W and S.
Moorshedabad ...	N. by E.	6	12	1-30	E.S.E. ?	N.W.	Changes of wind not stated.
Azimgunge ...	N.	9	1-30	2	E. ?	W. ?	Changes of wind not shown.

It will be seen at once from the above table that the phases of the storm at Rungamuttee were exactly the same as at Berhampore, but that the calm commenced one hour earlier, and only lasted for one hour. It is thus probable that the same vortex which passed over Berhampore passed over this place an hour earlier. If we assume that the lull which was felt at Kandi commenced about half an hour earlier than the time stated, the vortex which passed over this place might also be indentified with the Berhampore vortex, and possibly with that which passed over Beldanga at the same time 14 miles to the east.

The account from Gonateea, 15 miles further W.S.W. along the same line of country, is not clear; but if the lull commenced at 12-30, as stated, the vortex which passed this place (apparently to the S.E. from the way the wind backed) cannot have been the same as the Berhampore vortex. Soory is 24 miles west of Gonateea. Here a lull commenced at 8 A.M. and lasted for half an hour. It is to be observed that the changes of the wind here were the same as at Gonateea. Dr. Barker writes to me that at Soory "there was no calm, but the force of the wind considerably abated, and was reduced to what might be called a fresh breeze." I am inclined on the whole to think that the lulls recorded at Soory and Gonateea and also at Bood-bood, in the Burdwan district, were not caused by the passage of any vortex near to those places, but were merely temporary cessations in the force of the wind, such as that which took place at Calcutta.

At Rampore Beauleah a lull commenced at 2 P.M., and lasted for two hours. From the wind directions before and after it would appear that a vortex passed over this place moving, from W.S.W. to E.N.E. It seems impossible, if the time given for the commencement of the lull be correct, that this could have been the same as the Berhampore vortex. It may, however, have been the same as that which passed over Azimgunge. It will be remarked that after the lull at the latter place the wind blew from N.E., as if the vortex had moved away to S.S.E. However, if there were, as there appear to have been, several vortices in existence at the same time, it is clear that the changes of wind cannot be relied upon as giving much information regarding the course of any one particular vortex.

The Moorshedabad vortex can hardly have been the same with that of Berhampore, but might be identified with the one which passed Azimgunge. Choa appears to have been only intersected by the eastern edge of some vortex, whereas the centre of the principal vortex of the storm seems to have passed over Beldanga, where a lull lasting for four hours is recorded.

It seems to be almost useless to try and speculate further as to the probable courses of the various vortices which appear to have been nearly simultaneous in existence in the neighbourhood of Berhampore. It is quite probable indeed that most, if not all, of them broke up shortly after being formed without advancing far. The data available are very meagre, and I am not at all certain that they are all reliable. However, so much may be inferred that there was a general progression of a vortex or a succession of vortices along the same general path between Burdwan and Berhampore. When the storm arrived in this latitude, its force seems to have been almost exhausted, and it had probably lost in a great measure its true cyclonic character and broken up into a number of separate eddies either stationary or moving along very irregular paths.

The direct distance between Burdwan and Berhampore is about 64 miles. If we reckon from 5-51 A.M., when the barometer was lowest at Burdwan, to 1-15 P.M., when it was lowest at Berhampore, this would give for the mean rate of progress of the storm between these places 8·6 miles an hour. Cutwa is almost exactly half way between Burdwan and Berhampore, but a little to the east of the direct line. It has been seen that the centre of the storm was probably nearest to this place about 9-30 A.M. This would give three hours between Burdwan and Cutwa, and four and half hours between Cutwa and Berhampore, or rates of ten and seven miles per hour, respectively, in round numbers.

Further Traces of the Cyclone.

The Collector of Rajshahye, Mr. W. H. D'Oyly, writes as follows about the storm as felt in his district:—

In the town of Rampore Beauleah the storm commenced about 3 A.M. on the 16th instant. At daylight the wind had increased, and was blowing from a point slightly N. of E. It gradually got stronger, and veered to the E. and then to S.E., and was accompanied with heavy driving rain until about 2 P.M., when it was nearer S. and at its strongest. Shortly after this there was a sudden lull till about 4 P.M., when it commenced blowing from a point slightly S. of W. in gusts, but not so violently as before. It veered by degrees to N.W., but subsided by evening. I enclose an extract from the meteorological register.* A number of fine trees were uprooted in the station, and many kutcha houses in the town were blown down or damaged. It is reported that about 100 boats were sunk at the ghâts, but many were subsequently raised. The storm seems to have been felt all over the district. Mr. Bashford, Manager of Messrs. R. Waston and Co.'s silk concern, tells me that a factory (I believe a kutcha one) to the east of Surdah was blown down. From the police reports it would appear that the violence of the storm was greater in the western thanas of the district than elsewhere, viz., Godagaree, Tannore,

* Extract from Meteorological Register kept at Rampore Beauleah on the 16th October 1874.

	Barometer.	Thermometer.	Wind.
10 A.M.	29·70	80	E.
4 P.M.	29·25	80	W.

Rainfall 3·8 inches.

and Manda, where it continued blowing till midnight. The ascertained loss of life caused by the cyclone on the 16th was as follows:—

One man drowned in Singra by the sinking of his boat.

One man killed by a falling branch.

Two men killed by falling walls.

The phases of the storm at Rampore Beauleah have already been alluded to. A vortex passed partly over the town with its centre a little to the westward. It has been stated that it is improbable that this was the same vortex which passed over Berhampore. The distance between the two places is about 30 miles. The lull at the latter did not end until 3 P.M., whereas at the former the lull commenced shortly after 2 P.M. The Rampore Beauleah vortex was probably formed about the same time as that which passed over Berhampore, but considerably in advance, along the same general north-north-easterly path. It was the western parts of the Rajshahye district, through which this mean path would pass, that the violence of the wind is reported to have been greatest.

The following extract of a letter from Mr. F. Wyer, Collector of Maldah, to the Government of Bengal, and its enclosure, gives an account of the gale which was felt in that district:—

I HAVE the honor to forward a copy of a letter of the Civil Medical Officer, which will furnish all the information I am able to give. There was no cyclone in this district, though the 15th and 16th were very stormy, so much so that a good number of trees were blown down in thana Gomastapore towards the south of the district, as well as a few huts, and six salt boats were sunk in the Mohanunda. The direction of the wind at head-quarters was not, as far as I observed it, due E., but slightly inclining to N., though the general direction was E., as stated by the Civil Medical Officer. No great damage resulted from the storm, and what damage was done was more than compensated for by the benefit the rice-crops derived from the rain.

Extract of a letter from BABOO DWARKA NATH CHATTERJEE, *Civil Medical Officer, to the Magistrate of Maldah.*

FOR five days before the 15th current, the weather was hot and dry; the mornings and evenings cool. A change was perceptible from the night of Wednesday, the 14th: clouds collected all around. All Thursday from morn to eve was very cloudy, threatening some great meteorological disturbance. A small quantity of rain fell towards evening; the wind became stronger during the night and veered from N.W. to E.; more rain fell. Friday was rainy and stormy. It blew almost a gale all day from E., increasing in severity in the afternoon and early part of the night. Towards morning the weather cleared, and Saturday became fair and sunny. The direction of the wind all along the storm was E. Its velocity could not be ascertained. The barometer at 10 A.M. of the 14th was 29·600, and at 10 P.M. of the same day 29·450. On the 15th it ranged between 29·550 and 29·500; on 16th it fell down to 29·250. The total quantity of rain collected during the two days was 3·09. The thermometer during these stormy days ranged from 84° to 75°.

From the above it appears that it was only in the thana of Gomastapore, adjoining the western part of the Rajshahye district, that the wind blew with any considerable force. The Civil Medical Officer states that the wind veered from N.W. to E. (or N. of E. according to Mr. Wyer) as the storm approached, but it seems unaccountable that it should have continued at this point while the storm was passing to the eastward.

The following correspondence contains all the remaining information which I have of the storm in the northern districts of Bengal.

Letter from E. J. BARTON, ESQ., *Collector of Bogra, to the Secretary to the Government of Bengal.*

I HAVE the honor to send you herewith, in original, a report by the Medical Officer of the storm which swept over this station last Friday. As the storm had certain peculiarities which are characteristic of the cyclone, I thought it possible that we here had one of the margins of a greater atmospherical disturbance which might be raging elsewhere. If such should have been the case, a report of what occurred here may not be uninteresting to the Meteorological Reporter.

Extract of a letter from ALEX. LYONS, ESQ., *Civil Medical Officer, Bogra, to the Magistrate of Bogra.*

ON the 15th, the day previous to the gale, there was continuous heavy rain, with moderately high, but variable, winds. The readings of my aneroid indicated unsettled weather, *i.e.*, it rose and fell alternately throughout the day. Total fall of rain up to 6 P.M. of this day was 1·34.

During the whole of the night of the 15th the sky was more or less overcast with rain-clouds. The morning of the 16th opened with frequently recurring short but heavy showers of rain, with fresh easterly breezes. The rain continued in fitful showers up to about 2 P.M., when the wind veered E. by N., accompanied by heavy continuous rain. The readings of the aneroid, which in the morning stood at 29·950, steadily fell to 29·725. The wind now begun to acquire force, and blew apparently from every point of the compass. At about 4 P.M. the wind gained in velocity, and thick clouds came rolling up from S. to N., the rain lulling for a short time. The thermometer in the north verandah of my house, which in the morning (7 A.M.) read 77°, now read 75°. About 7 P.M. the gale had fairly set in; the readings of the aneroid falling to 29·625, and the thermometer standing at 73°, and the rain now falling scantily. At 9-26 P.M. the barometer read 29·575, and the thermometer 77°. The wind now blew in blasts with great intensity, boxing the compass. 10 P.M., barometer 29·550; thermometer 76°; winds blowing furiously, in heavy gusts. 11 P.M., barometer 29·550; thermometer 76°; force of wind abating; scanty rain; sky black. At midnight the barometer began to rise, the wind gradually losing in force, though still blowing in gusts. 1 A.M. (17th October), barometer 29·700; thermometer 75°; still blowing in blasts; force considerably abated. 6 A.M., barometer 29·800; thermometer 73°; gentle breezes from the E. The rainfall up to 18 hours of the day of storm was 3·10.

The storm-wind blew fiercest between the hours of 8-30 and 11 P.M., apparently in a south-easterly direction. Considerable damage, as was to be expected, has been done to the thatch of all the houses of the station. Young trees have been felled, and heavy boughs of the larger trees have been wrenched off. I am glad, however, to add that up to the hour of writing (6 P.M.) the loss of no lives has been reported.

Extract of a letter from BABOO BROJO KANT RAI, *Deputy Collector at Gyebunda, to the Collector of Rungpore.*

IN compliance with your circular memorandum No. 459, dated 28th instant, calling for statistics concerning the recent cyclone, I have the honor to report that the wind commenced blowing from the N.E. at about 7-30 P.M. on the 16th October 1874. It gradually increased in velocity and fury, and veering round through the E. and S., at last died out at the S.W. at about 4 A.M. Many houses and their bamboo enclosures have been blown down. Some five boats laden with jutes, and anchoring at the mouth of the Teesta near Kalmee, have been overturned and foundered. No loss of life or any such serious accidents took place.

Extract of a letter from BABOO KRISHTO DHONE GHOSE, M.D., *Civil Surgeon of Rungpore, to the Magistrate of Rungpore.*

FROM the 6th of October there was no rainfall, and the temperature began to rise steadily, being characterized by a sultriness, showing itself more by high minimums than extraordinary maximums. The barometer showed little fall. From the 13th, clouds began to show themselves in the horizon. On the 15th, the clouds thickened, and after nightfall it began to rain slightly, and the wind began to blow from the E.N.E. Next morning, *i.e.*, on the 16th, there was drizzling rain, and the wind rose, little changing its direction. In the afternoon, the wind increased markedly in force, and veered more to the N. and kept the easterly inclination till about 9 o'clock P.M., after which it blew violently and was due N. After midnight, it changed to N.W., then W.; and in the morning of the 17th it was S.W. The velocity and force of the wind was highest after midnight, when the wind was N.N.W. The barometer showed little change, but the instrument I have is an old aneroid, and cannot be trusted. The rain during the storm was very heavy. Up to 6 P.M., on the 16th, 1·89 inches fell, but in the course of the night and the following morning the fall amounted to 6·97 inches. The velocity was not observed, but it could not have been very great, as the damage done was very little. Except a few branches of trees, and here and there a weak-rooted tree, nothing was laid down, nor was any damage done to any property. It seems that this town was on the extreme left border of the path of the cyclone.

At Bogra the gale commenced about 7 P.M., and was at its height at 10 P.M., the wind having apparently veered round from E. by N. to S.E. The centre of the storm was probably nearest, to the westward of Bogra, about the latter hour, and judging from the fall of the barometer, compared with the greatly diminished intensity of the storm, was not at any very great distance. The

centre probably passed very near the junction of the river Teesta with the Brahmapootra, where the wind seems to have been more powerful than at other places in the neighbourhood.

At Rungpore the wind was from E.N.E. until 9 P.M., when it commenced to back to N. and gradually got stronger. After midnight the wind was strongest, and during the early morning of the 17th it backed further to N.W. and W. Some time after midnight the centre of the storm was passing to the eastward of Rungpore, but at a considerable distance, as the wind does not seem to have been nearly as strong at this place as at Bogra or Gyebunda.*

In the meteorological register kept at Goalpara in Assam, about 80 miles in a direct line N.E. from the junction of the Teesta and the Brahmapootra, the approach of the cyclone is clearly traceable. The barometer, which was about at its normal height at 10 A.M. of the 16th, showed a fall of 0·123 at 4 P.M. from the same hour of the previous day. On the 16th the wind was at N.E., and appears to have continued from this quarter until the afternoon of the 17th. However, the observations are only recorded twice a day—at 10 A.M. and 4 P.M. The mean velocity of the wind from 4 P.M. of the 15th to 10 A.M. of the 16th was only two miles an hour. From 10 A.M to 4 P.M. it was eight miles, and from 4 P.M. to 10 A.M. of the 17th it increased to 13 miles. From 10 A.M. of the 17th to 4 P.M. it again decreased to 10·5 miles. By 10 A.M. of the 17th, however, the barometer had risen nearly to its normal height, and before this hour it is probable that the storm had broken up on the western ridge of the Garo Hills at no great distance from Goalpara.

It would appear that after passing Berhampore the general path of the centre of the storm became more easterly, curving round from N.N.E. to N.E. Along this path the distance travelled between Rampore Beauleah and Bogra would be about 56 miles approximately in seven hours, giving a rate of eight miles an hour. It is impossible to estimate with any approach to accuracy the rate of progress after this. Forty-five miles further along the same path would place the centre of the storm near the mouth of the Teesta and nearest to Rungpore. The wind was strongest at the latter place from N.N.W. after midnight—time not stated. The time, however, can hardly have been much later than 2 A.M. of the 17th as the wind had died away at Gyebunda at 4 A.M. If we assume that the centre of the storm was nearest to the mouth of the Teesta at 2 A.M., the rate of progress from Bogra would be over 11 miles an hour.

* Gyebunda is about 8 miles S.S.W. from the junction of the Teesta and Brahmapootra.

SECTION V.

Concluding Remarks.

Two Theories of the Origin of Cyclones.—In the data which have been reviewed in Section II there is no evidence of the existence of the cyclone before the night of the 13th, when the *Udston*, in about latitude 17° N., had the wind backing from S.W. to S.E.; and the Arab ships *Chanticleer* and *Fazel Carreem*, in about latitude 18° N., had northerly winds veering round towards E.N.E. The ship observations would be consistent with an origin of the storm between latitudes 16° and 17° N., and longitudes 89° 30′ and 90° 30′ E., on the forenoon of the 13th. If it could be affirmed with certainty that the storm had its origin in this locality about the time stated, considerable light would be thrown on the mode of generation of cyclones in the Bay of Bengal. For it appears that from noon of the 12th strong, squally north-easterly winds set in at about latitude 17° N., and extended as far north as 19° by noon of the 13th; while, on the other hand, the log of the *Udston* shows that from about latitude 13° to 16° N. wet, squally W.S.W. gales prevailed. Some confirmation, as regards its applicability to the Bay of Bengal, would hence be afforded to the theory that cyclones are generated in the belt between two parallel (or nearly parallel) currents flowing in opposite directions, which Mr. Meldrum has applied to account for the formation of hurricanes in the South Indian Ocean. The existence of such opposite currents before the formation of a cyclone implies the previous existence of comparatively high atmospheric pressures south and north of the locality of the storm's origin. It has been shown, in the first section, that such, in this instance, was the case; that the pressure to the southward, at Nancowry and Port Blair, was very abnormally high throughout the whole of the early part of October, and up to the time of formation of the storm. The pressure to the northward, over Bengal, was also above the average on the 10th October. It is to be remarked that the zone of westerly squally winds seems to have gradually advanced northwards, from the 4th or 5th of the month, up to the time when the cyclone was formed. The ships *Ireshope* and *Patrie* had squally weather, accompanied by heavy rain, from about latitude 5° N., on the 6th October, up to between latitude 13° and 14° N. on the 8th. But the *Udston* coming up the same part of the Bay between the 8th and 9th had comparatively fine weather, and did not run into the belt of westerly gales until about latitude 13° N., on the afternoon of the 12th. The advance of the monsoon northwards during this period is also traceable in the meteorological registers for Nancowry and Port Blair. At the former place the weather, which had been very bad in the early days of the month, cleared up on the 10th. At the latter it got worse up to the 12th and 13th. This would appear to confirm the supposition that the storm was formed about the locality and time which has been indicated, somewhere along the belt of collision of the W.S.W. and N.E. currents.

Given the existence before-hand of two nearly opposite colliding wind-currents, and hence by necessity an ascending current in the belt between, the production of a cyclone can be accounted for on dynamical principles. The existence of a damp, squally W.S.W. current for some days previous to the formation of all the cyclones in the Bay of Bengal which have been traced back to their place of origin, is unquestionable. Considerable doubt, however, has been thrown on the *previous existence* of the north-easterly current. Mr. Blanford, who is one of the highest authorities on questions relating to the meteorology of this region, holds that the theory of the formation of cyclones between two contrary and pre-existing winds is not applicable to the storms of the Bay of Bengal.* His own theory appears

* "Winds of Northern India"—Appendix on cyclones.

to be that a local atmospheric depression is the primary cause of the formation of a cyclone, and that it is only when the winds have commenced to circulate round this area that the north-easterly current sets in to the northward. He attributes the local atmospheric depression to a high local temperature, possibly produced by hot marine currents from the south.* When the local atmospheric depression is formed, the cyclone is supposed to be generated by the influx of three principal wind-currents from S.W., S.E., and N.E., to the pre-existing area of barometric depression.† Some evidence in favour of the existence of a local barometric depression before a cyclone has been given by Mr. Blanford in papers communicated to scientific societies and in reports to the Government of Bengal. It may be remarked that the pre-existence of a relatively low pressure is also required by the theory of opposite currents. This relative depression, however, would not necessarily be local, but would probably extend along the whole belt between the W.S.W. and N.E. currents. The question to be decided between the two theories would seem to be mainly reduceable to the question of determining which of two phenomena is the antecedent and which the consequent. Mr. Blanford, as I take it, holds that the primary cause of the formation of a cyclone is a local one, viz., a barometric depression, and that the circulation of the wind-currents round this local depression is the after effect. On the other hand, the theory of contrary winds appears to imply that the primary causes are far removed from the place of formation of the storm, viz., an abnormally high pressure to the southward and also to the northward, at considerable distances, giving rise to a relatively low pressure between. This accounts for the nearly opposite wind-currents, which, gradually approaching each other and producing an ascending current along the intermediate belt, ultimately give rise to a cyclone.

Either of the above theories, I have little doubt, would be sufficient to account for the formation of a cyclone, given that the conditions as stated existed beforehand. I express my own opinion on the subject with considerable diffidence. It appears to me that the theory of opposite currents, perhaps slightly modified in accordance with local circumstances, fits in with the observed facts (which are, however, unfortunately not as numerous and reliable as might be wished) at least as well in this instance as the local depression theory. Taking for granted that the cyclone was not formed before the 13th of October, all the conditions required by the theory of opposite currents existed beforehand. As far as the data show, the winds were north-easterly all over the Bay north of latitude 17° N., at least as early as noon of the 11th, and west-south-westerly south of about latitude 15° N. The north-easterly surface-winds were undoubtedly very light, except near the locality where the storm is supposed to have been formed; but the cloud observations would seem to show that the upper north-easterly current was moving with much greater velocity than the surface-wind. The master of the *Patrie* observed the clouds overhead moving with great velocity even on the 11th, when the surface-wind was very light. This phenomenon is always observable for some time before a cyclone. The motion of the lower clouds appears to be extremely rapid, even when the surface-wind is not stronger than a gentle breeze. It seems, therefore, not improbable that long before the N.E. surface-wind‡ commences to blow with any strength,

* Proceedings, Royal Society, No. 113, 1869, pp. 480, 481.

† Proceedings, Royal Society, No. 113, 1869, p. 479.

‡ I have refrained from calling this current the "North-East Trade" (which has been the practice with some writers), as opinions seem to be divided as to whether it can properly be called a trade-wind or not. That such a current, however, prevails over a large portion of the Bay for the greater part of the year, even when the surface-winds over the southern parts of the delta are southerly, as in March, April, and May, there is no doubt (see Blanford's "Winds of Northern India" and Maury's "Physical Geography of the Sea"), and it matters little for the question at issue whether it be called a *trade* or a *monsoon*. This north-east wind has complete possession of the Bay in the winter months, and it is only when the the south-west monsoon is in full force, from about 1st of July to the end of August, the limits varying in different years, that it is completely obliterated at sea. The southerly winds which are felt over the land in the south of the delta before the south-west monsoon proper sets in, and probably also at its close, are surface-winds only of no great depth, and are due to a dragging down and back of part of the N.E. current above, in consequence of the rarefaction of the air over the heated plains of the delta. (See Blanford's "Winds of Northern India," page 25.) These southerly winds, however, do not extend far out to sea, where the N.E. current flows on uninterrupted. That there is above the N.E. current a return current, or *anti-trade*, I have little doubt. I have observed the motions of the upper clouds on different occasions over the moon's disc at night to be from S.W. to N.E. when the surface-wind was N. E. My attention was especially called to the existence of this anti-trade on the occasion of the late Transit of Venus. On the 9th December the wind at Calcutta was light from N.E. or E.N.E., and the sky was partly covered with cirro-cumuli, which, seen by the naked eye, were apparently motionless. Looking through a telescope, however, they were seen moving rapidly over the sun's disc from N.E. to S.W., apparently, the true direction of motion being therefore from S.W. to N.E., allowing for the inversion of the astronomical telescope which I used.—W. G. W.

there is an upper N.E. current from the region of high pressure to the region of relatively low pressure. This current is drier, colder, and heavier than the opposing damp W.S.W. current, which must, therefore, be forced upwards along the belt where the winds collide, and where the N.E. current descends. The W.S.W. current appears to be always the more powerful of the two. This fact is explained, in the present instance, by the high pressure at Nancowry compared with the pressure over Bengal. However, it would seem probable that a very gentle N.E. current, or even a calm, dense atmosphere, would be sufficient to check and force upwards the powerful but less dense W.S.W. monsoon, thereby producing the enormous precipitation of moisture which is always observed near the place of origin of a cyclone, and which probably plays a very important part in its formation. As the precipitation of moisture continues, the atmospheric pressure diminishes along the head of the W.S.W. monsoon. The north-easterly current hence becomes more vigorous, and gradually extends northwards as a strong surface-wind. Ultimately the N.E. current becomes sufficiently powerful to generate the cyclone. The above is a short sketch of how it appears to me the theory of opposing currents may be applied to account for the formation of the cyclones of the Bay of Bengal.

In favour of the local depression theory it may be argued that it is possible that the cyclone was formed before the 13th, and before the N.E. current had set in, considerably to the S.S.E. of the locality which I have indicated, or that the winds were circulating round a place of low barometer for some days before the storm was set in motion. In opposition to this I would say that the wind observations as given in the log of the *Udston* (if they can be relied upon) are not consistent with the supposition that the storm was progressing northwards from more southern latitudes on the 12th and the morning of the 13th, as the ship had westerly winds until she got above latitude 16° N. There also does not appear to have been any tendency of the winds to circulate round a local barometric depression in the neighbourhood until about the time when I suppose the cyclone to have been formed. This is a point of great importance in the evidence in favour of the theory of opposite currents. Before a cyclone, and during its approach, north-easterly winds prevail over many degrees of longitude to the north of the storm, both on the eastern side and on the western side of the path subsequently pursued, and there seems to be no marked tendency of the winds to circulate round a local depression until the cyclone is near at hand. The same remarks apply to the W.S.W. monsoon south of the storm's place of origin.

Uncertainty of Cyclone Prognostics.—It may be useful to make a few remarks regarding the uncertainty of the weather indications, as observable at Calcutta and Saugor Island, which precede cyclones in the Bay at the close of the south-west monsoon, in October and the early part of November, before any decided fall of the barometer or increase in the force of the wind is noticed. This uncertainty relates, not to the actual existence of such a storm somewhere in the Bay at the time, but to its probable position and subsequent course.

On the forenoon of the 15th of October at Calcutta, although the barometer up to 10 A.M. had fallen but slightly, it was evident from the drifting of the clouds overhead, which always appeared to move with a much greater velocity than the light surface-wind would account for, that an unusual atmospheric disturbance was in existence somewhere in the Bay. These signs, however, which are never absent, as far as my experience goes, whenever there is a cyclonic disturbance anywhere in the middle or northern parts of the Bay, were not alone sufficient, in the absence of any considerable fall of the barometer, to give any information regarding the probable distance and position of the storm, or the course which it would ultimately pursue. The same may be said of the weather tokens at Saugor Island before the early morning of the 15th. The very same idications of cyclonic disturbances in the Bay were quite as strongly marked, as on the forenoon of the 15th, in Calcutta on three subsequent occasions at the close of the late south-west monsoon. These occasions

were the 26th and 27th of October, the 1st and 2nd, and the 11th and 12th of November. On the evening of the 26th of October a cyclone reached land a little south of Coconada, and the influence of this storm was also felt at Madras as it passed up the Bay on the 24th and the morning of the 25th. On the 2nd of November another cyclone was felt at Coconada; and on the 11th and 12th of November the S. S. *Meinam*, which had left Madras for Calcutta on the 9th, overtook a third cyclone about latitude 18°N. The bad weather resulting from this latter storm was severely felt at False Point and at the Sandheads. All that is known of the circumstances of these cyclones will be recounted in the Meteorological Report for the year. On these three occasions, however, and specially in the case of the Coconada cyclone of the 26th October, the weather at Calcutta was quite as threatening as on the forenoon of the 15th, and the behaviour of the barometer very similar. On the 25th of October the barometer was high for the season, and had been rising since the 22nd. There was a fall of 0·057 from 10*h.* of the 25th to 10*h.* of the 26th—a little greater than the fall from 10*h.* of the 14th to 10*h.* of the 15th. On the morning of the 26th the sky was overcast with a light breeze from E. by N.; the clouds overhead were moving rapidly past from N.E. to S.W. and there was occasionally drizzling rain. In fact, all the appearances of a cyclone coming up the Bay were as strongly marked as on the morning of the 15th. Although the same weather continued until the afternoon of the 27th, the barometer did not fall further, and soon commenced to rise; and it turned out afterwards that the cyclone was never nearer to Calcutta than Coconada, about 530 miles distant. The disturbance, however, which preceded and accompanied the Coconada cyclone of the 26th seems to have extended over a much larger area of the Bay than in the case of the storm under discussion. During the passage of the storms mentioned above, the weather indications at Saugor Island were very similar to those at Calcutta, but, as usual, earlier and more strongly marked. The march of the barometer was also identical, and the slight fall, when the storms were nearest, was but little greater than at Calcutta.

The above are a few instances, and many others could be cited from the storms of former years, to illustrate the uncertainty which attends the prediction of storms at the close of the south-west monsoon. From the general appearances of the weather at Calcutta and Saugor Island it can be stated, with a high degree of probability in such cases, for some time beforehand, that there is a cyclone somewhere in the middle or northern parts of the Bay. This, however, is all that can be predicted until either a decided fall of the barometer and an increase in the force of the wind show that the cyclone is approaching, or until the rise of the barometer and the disappearance of the bad weather symptoms show that it has either broken up or passed by.

There appears to be an important distinction between the storms which visit the shores of Bengal at the change from the south-west to the north-east monsoon and those which occur at the change from the north-east to the south-west monsoon, as regards the period of warning afforded by the general signs of the weather and the fall of the barometer. The former storms are usually generated somewhere in the eastern part of the Bay about, or a little north of, the latitude of the Andaman Islands; and, although in that locality the formation of the storm is preceded by many days of bad weather, and probably low atmospheric pressure, there are usually no weather indications along the coast-line of Bengal of the existence of the storm until a day or two before its arrival. The duration of the warning period varies, of course, in different cases, according to the magnitude of the storm, its rate of motion, and the extent of the atmospheric disturbance which precedes and accompanies it. However, the area of low atmospheric pressure to the northward of a cyclone, when it has advanced up the Bay to some distance from the latitude of its origin, appears to be of no very considerable extent relatively to the magnitude of the storm itself. Thus it is not until a place is near the limit of the gale of wind which surrounds the body of the advancing cyclone that any decided fall of the

barometer takes place. The above remarks, which have been suggested by the case of the particular storm now under discussion, are equally true of the great Calcutta cyclones of the 5th October 1864 and the 1st November 1867; and I venture to say they will be found, on examination, to hold in the case of all recorded cyclones which have arrived at the shores of Bengal from the middle or southern parts of the Bay.

The storms which visit the shores of Bengal at the commencement of the south-west monsoon are usually generated in the northern part of the Bay, and the atmospheric disturbance which precedes them appears to be sufficiently near to affect considerably the pressures and gradients and the general character of the weather round the north of the Bay for some days before they are formed. The barometer falls steadily and considerably, generally for four or five days beforehand. The atmospheric gradient between Calcutta and Saugor Island becomes reversed in direction,* the pressure at Saugor Island falling below that at Calcutta (normally at the time of year the pressure at the former place is higher), and north-easterly winds become prevalent at the head of the Bay. At this time of year (May and June) the normal wind directions in this locality are southerly and south-westerly, and winds from the north-east (the cyclone quarter) are very unusual; whereas in October and November north-easterly directions are not uncommon at Calcutta and Saugor Island, and along the shores of Orissa, and generally over the north-west of the Bay, north-easterly winds predominate. The barometer at Saugor Island also ranges normally below that of Calcutta, so that the atmospheric gradient does not change but only becomes more intensified as the cyclone approaches. Thus the weather indications which precede the actual formation of a cyclone in the northern part of the Bay, at the commencement of the south-west monsoon, are clearly defined; whereas, in the case of a storm coming up from the middle or southern parts of the Bay only the indications which precede the actual approach of the cyclone are noticeable, and even these signs are less definite in October and November than in May and June, on account of the normal conditions being only intensified in the one case, whereas they are completely reversed in the other. In the one case the conditions are changed, both in kind and in degree; in the other case they are only changed in degree.

This cyclone was remarkable, as has been before pointed out, for the steepness of the barometric gradient and the comparatively small extent of the atmospheric depression in front of the storm as it advanced. Although the vortex itself was of comparatively large diameter, and the barometric depression at its centre probably as great as in any recorded cyclone, the area of the body of the hurricane was unusually small, and its limits remarkably sharply defined. The shortness of the warning given by the barometer of the approach of the storm at the Sandheads has already been noticed, and is further illustrated by the barometric curves for the *Coleroon* and Saugor Island on Plate I. at the end. The fact that the two pilot vessels, which were on the station at the time, were both caught in the vortex while endeavouring to get to sea also points to the suddenness with which the cyclone burst over the Sandheads. The commanders of the pilot brigs, well acquainted with all the phenomena of the cyclones of this region, and perfectly familiar from long experience with all the indications of their approach, generally manage to keep their vessels at least at a safe distance from the centre of any storm which may be travelling up the Bay. It is a point of honor, however, as well as a necessary rule, to hold on to the station as long as it may appear safe to do so: as when the brigs run down to the southward it may take them some days to get back, and great inconvenience and delay may thereby be caused to vessels either outward or inward bound. In the present case the commanders of the brigs seem to have misjudged the distance of the storm, probably misled by the slowness of the fall

* In the months of May and June the atmospheric pressure to the north of the Bay is rapidly decreasing to the solstitial minimum, but during the same period the decrease of pressure to the south of the Bay is very inconsiderable. In June the average gradient between Port Blair and Saugor Island is about two-tenths of an inch of mercury. In October the pressure to the north of the Bay is rapidly rising, the rate of increase being more than twice as great as the rate of fall in the former season. There is also a slight increase of pressure in the south of the Bay at this season, but there is usually no marked gradient between Saugor Island and Port Blair, the pressure at the change of the south-west monsoon being almost uniform all over the Bay.

of the barometer before they were actually within the radius of the hurricane, and they did not try to get out of the way until it was too late.

The gradient towards some of these cyclones of narrow diameters and deep depressions is, as has been noticed, at first very slight, and only becomes steep when the wind is commencing to blow with the force of a gale. To make much use of the slight fall of the barometer beforehand, in such cases, in foretelling the approach of the storm, requires not only an accurate knowledge of the normal diurnal oscillations, but also that systematic observations of a good standard barometer should be regularly recorded from day to day. It is well known to meteorologists, and should also be well known to all who are engaged in the navigation of these seas, that the barometer in these latitudes has four diurnal oscillations, which are perfectly regular in settled weather—two maxima, at 10 A.M. and 10 P.M., and two minima, at 4 A.M. and 4 P.M. The highest maximum is at 10 A.M., and the lowest minimum at 4 P.M. The difference between the 10 A.M. and 4 P.M. readings varies with the time of year, but is, in round numbers, about one-tenth of an inch of mercury. This may seem a small amount to some who are accustomed to the greater, though irregular, variations of higher latitudes. However, if much use is to be made of the barometer in foretelling hurricanes in these regions, masters of vessels must be prepared to measure and record not only variations of one-tenth of an inch, but also variations of the one-hundreth and one-thousandth parts of an inch, and must provide themselves with a better class of barometers than the old-fashioned instruments in common use, few of which will give the second decimal place with any approach to accuracy.

In consequence of the regular diurnal oscillations above mentioned, it is only by comparing the height of the barometer at any given hour with its height at the same hour of the preceding day that a fall or rise can be ascertained. Thus a stationary barometer from 4 A.M. to 10 A.M. during which period the barometer normally rises, would indicate a considerable decrease of mean pressure; whereas a fall of one-tenth, or even fifteen-hundredths, between 10 A.M. and 4 P.M. would not be inconsistent with a considerable increase of mean pressure. Hence the necessity of making regular observations and recording them each day for the comparisons of the following day. The best plan is to make and register accurate observations four times a day at the maxima and minima periods above mentioned, and to compare the observations of each day with those of the preceding day. When it is necessary to take readings at intermediate hours, in unsettled weather, the height of of the barometer at the same hour of the previous day may be calculated, for the purpose of comparison, by adding or subtracting a proportional part to the reading which was made at the last maximum or minimum epoch. Thus, to ascertain the height of the barometer at noon from the 10 A.M. and 4 P.M. readings, one-third of their difference should be subtracted from the former. The readings of the barometer should, in all cases, be reduced to the temperature of 32° F. before any comparison is made. This, of course, requires that the attached thermometer should be read when the barometer is observed. It is only thus that accuracy can be obtained, as the mercury rises with heat and contracts with cold independently of any change of pressure. The reduction may be effected by subtracting a correction given on a page of tables from the observed reading, and involves no trouble or time worth mentioning. If such precautions be taken a good barometer will always give, in combination with other well known weather indications, warning of the approach of a cyclone sufficiently ample to afford plenty of time to get out of the way; and it is only when such precautions are taken that the barometer will do much more, in the case of many storms in these regions, than to register the different stages in their progress without *foretelling* their advance. Merely glancing at the barometer to ascertain whether it points to fair weather or foul weather, or whether it is rising or falling at the time, is utterly useless in the Tropics.

It is almost needless to add, to what has been said above, that a decrease of mean pressure, say as much as one-tenth, or even fifteen-hundredths of an inch,

ascertained in the manner described above from comparison with the pressure at the same hour of the previous day, would not in all, or even in most, cases indicate the approach of a storm, as such a fall might be caused by the passage of an ordinary atmospheric wave. Such a fall would, however, be much more significant at the close of the south-west monsoon, when the pressure is normally increasing, than at the commencement of the same monsoon, when the pressure is normally falling. But there are other indications of the approach of a cyclone, besides a falling barometer, which are well known to the mariner, and which will enable him to judge whether the fall of his barometer in any case is due to an ordinary atmospheric oscillation, or to a cyclonic disturbance near at hand. Among the indications at the Sandheads the earliest is probably afforded by the motions of the lower clouds, which drift rapidly by in dark elongated masses from N.E. to S.W., and this is one of the surest tokens of the existence of a cyclonic disturbance. The mean direction of the wind at the Sandheads before a cyclone is always N.E. or E.N.E., more usually the latter when the place is on the track of the storm, but it varies considerably in the gusts, which are always fitful, but increase in strength as the storm approaches. The squalls also become more frequent, and the driving rain which accompanies them gets gradually heavier as the cyclone approaches, and a heavy sea swell comes up from the south-eastward. With such indications, even if the barometer up to the time has shown no very considerable fall, it may be concluded that the cyclone is not very far away, and it may be expected that the barometer will give less warning of the approach of a storm in October than in May or June.

The Form of Cyclones.—One of the most important practical questions for navigators in connection with the phenomena of cyclones is the bearing of the centre of the storm with reference to the direction of the wind at any time. According to the earlier writers on the "law of storms" cyclones were believed to be true circular storms represented by a number of concentric circles, from which it would follow that the direction of the centre would always be at right angles to the direction of the wind. It has gradually, however, been brought to light, by carefully plotting on charts synchronous wind observations made in different storms, that the air currents do not blow round the centre in concentric circles, but in spiral curves, which, at a distance from the centre, are nearly rectilinear, but whose curvature increases approaching the vortex. For the last ten or twelve years the circular theory has been generally abandoned by those meteorologists who have made the subject a special study. It is feared, however, that the rules founded on the older views are still those which are mostly acted upon by mariners, and many losses at sea have probably been due to an incorrect estimate of the bearings of the centres of cyclones founded on the circular theory. The subject is of such immense practical importance to all concerned in navigation that no opportunity should be lost of pointing out that the true course of the wind is in a spiral curve whose curvature gradually increases towards the centre of the storm.

In Section III the different bearings of the centre of the storm at 1 P.M. of the 15th, with reference to the wind directions at the time at the several floating light-vessels and neighbouring land stations, have been noticed. It will have been seen that in no case was the angle, measured in the direction of the hands of a watch, between the wind and the direction of the centre less than nine points, but that in some cases it was as great as twelve, and probably as great as thirteen points in others. The course of the wind is also further illustrated in the chart, Plate II., on which I have plotted the synchronous wind observations for 10 A.M. and 4 P.M. of the 15th, and marked the approximate positions of the centre of the cyclone at these hours.

It is unfortunately impossible to give any one simple rule for determining the bearing of the centre from the direction of the wind in a cyclone which would apply to all cases, as the angle between the wind and the centre is different at different distances and positions. In a report on the Balasore cyclone of 1872 I recommended the following rule to be used when near the circumference

of the hurricane: that is, when the barometer would be commencing to fall rapidly and the wind to blow with the force of a heavy gale:—To find the bearing of the centre in the northern hemisphere "stand with your face to the wind, and measure round to your right hand side ten points" instead of eight, according to the circular theory. This rule would probably give the direction of the centre very closely in most cases under the specified conditions, and, at all events, would always be better than the old rule of eight points. But I added in 1872 that at a distance the centre might bear 11, 12, or 13 points from the direction of the wind. I have some reasons to conclude that the wind directions were, on the whole, more convergent during the worst part of the cyclone now under report, while it was passing over the north-east corner of the Bay and the south of the Midnapore district, than they were throughout its subsequent course, and also more convergent than in the case of the Balasore cyclone of 1872. It seems probable, indeed, that there should be some relation between the degree of convergence of the winds and the steepness of the gradient to the vortex; and we should expect to find the winds more convergent in a narrow hurricane, with a very deep depression at its centre, than in the case of cyclones of a less violent character, or those covering more extensive areas.

Mr. Meldrum, in a paper on "The Form of Cyclones in the Southern Indian Ocean," has given some instances in which the wind blew directly towards the vortex. In these cases, however, the distances from the centre of the storm were very considerable. Analogous cases will be seen on the chart, Plate II. Thus, at 10 A.M., the wind at Cuttack was west and blowing directly towards the centre of the storm, which was then east from that place. However, Cuttack was 125 miles from the centre, and the wind was not stronger than a light breeze. From all the cases which I have examined I am disposed to think that anywhere within the outside circumference of the gale of wind which surrounds the body of a cyclone the angle between the mean direction of the wind and the centre, measured round in the opposite direction to the rotation of the storm, is seldom greater then 13 or less than 9 points.

The following rule may be used to determine the approximate bearing of the centre with as much accuracy as it seems to be possible to arrive at:—*In the northern hemisphere, with the face to wind, the direction of the centre is from ten to eleven points to the right hand side.* In the southern hemisphere the angle is, of course, to be measured to the left hand side, or, in both cases, in an opposite direction to the rotation of the storm. If with this rule it be also remembered that at a distance from the centre the angle is larger and may be as great as twelve or even thirteen points, while near to the vortex it is smaller and may be as little as nine points, the Navigator will probably have, combined with the weather indications at the time and the behaviour of his barometer, sufficient information of the bearing of the centre of a cyclone to enable him to avoid the worst part of the storm, if not to keep out of it altogether. The immense importance of keeping out of the hurricane belt, even when unable from circumstances to escape from the gale of wind outside, will be acknowledged by all who have had the misfortune of being caught in the vortex of a cyclone. A distance of ten miles may make all the difference between being totally dismasted, if not foundering, and the loss of a few sails and spars.

Probable Mode of Formation of the Cyclone.—The Midnapore and Burdwan cyclone, of the 15th and 16th of October 1874, was probably generated between latitudes 16° and 17° N., and between longitudes 89° 30′ and 90° 30′ E. on the forenoon of the 13th of October. Its formation was preceded in the early days of the month by an unusually high atmospheric pressure in the south of the Bay, and also later on by a high pressure in the north of the Bay and over Bengal. It seems to have been in the trough of relatively low pressure between these high pressures that the cyclone was ultimately generated, and also probably propagated. From the 4th or 5th of the month, and probably earlier, wet, squally west-south-westerly winds prevailed from about latitude 5° or 6° N. over some degrees of latitude northwards. This monsoon probably extended at last as far south as the equator, but it appears to have been only towards its northern limits

that the weather was bad and the rainfall very considerable; and this zone of wet, squally weather gradually moved northwards up to the time when the cyclone was formed. North of the head of the monsoon the winds were very light and variable, calms were frequent, and the weather was very close and warm ; still further north, the winds were light, mostly from north-easterly directions, and the pressure continued to increase over the north of the Bay and Bengal until just before the generation of the storm. This increase of pressure to the northwards, and the decrease of pressure along the head of the W.S.W. monsoon, caused by the precipitation of its moisture as it advanced and was forced upwards by the denser currents descending from the north-east, increased the sharpness of the gradient to the northward, which was probably at first inconsiderable. As a consequence, the north-easterly currents commenced to get more powerful to the north of the head of the monsoon and gradually extended further northwards as strong surface winds. So far the antecedents would be two nearly parallel wind currents blowing in opposite directions, and an ascending current in the trough of low pressure between, and if the two winds pressed equally against each other no rotatory storm would be generated. It seems to be doubtful whether the tendency of the winds to circulate round the margins of a trough of low pressure according to the law of rotation in the northern hemisphere would *alone* be sufficient to determine the formation of a vortex. However, there is reason to assume that the W.S.W. monsoon should be more powerful at its eastern limits, where, having passed over a greater extent of sea, it would have the maximum charge of vapour. And also, although in a much less degree, the north-easterly currents would be more vigorous towards their western limits. Hence the monsoon would penetrate further into the region of the N.E. current at its eastern limits, where also its opponent would be weakest. It is easy to see how these circumstances combined with the effect on the currents of the earth's rotation would determine a focus of depression at the eastern extremity of the trough of low pressure, and ultimately the formation of a vortex.

The above sketch represents, I believe, the mode of the generation of cyclones in the Bay of Bengal. Their occurrence in different latitudes at different seasons is explained by the varying positions of the calm belt between the S.W. or west monsoon and that from the N.E. or east. On the average, from the middle of September to the end of December, a line of low barometer moves from about the parallel of 18° N. to the parallel of 5° N. The storms which are generated in September and October, somewhere between the parallels of 14° and 18° N., are those which most frequently visit the shores of Bengal ; while the storms of November and December, which are generated further south, are usually only felt along the Madras coast. In the change from the N.E. to the S.W. monsoon the circumstances are somewhat different. A ridge of high pressure, which gradually moves southwards, extends across the Bay, separating the low pressure in the north of the Bay, and over the delta, from the low pressure in the south of the Bay. North of this ridge the surface-winds are southerly while to the southwards the N.E. current flows on uninterrupted (see Blanford's "Winds of Northern India," pages 25 and 47). South of this ridge, between an easterly and a westerly monsoon, are generated the storms which visit the shores of Madras in April and May, but which are seldom felt in Bengal. In the latter month, however, when the south-westerly winds in the north of the Bay blow over a sufficient extent of sea to acquire a considerable charge of vapour, an increase of pressure to the northwards might be sufficient to determine a trough of low pressure in the northern part of the Bay, between two high pressures, and thus cyclones might at this season be generated in the northern parts of the Bay as well as in the southern. However, the storms generated in the north of the Bay would not be expected to attain the same magnitude or violence as those generated in the south of the Bay, as the moisture of the south-westerly wind would be derived from a comparatively limited extent of sea. There are cases, however, in which storms generated in the south-eastern part of the Bay at this season have reached the shores of Bengal. The Cuttack cyclone of 1840, which was formed south-east of Port Blair, is an example. In

June the ridge of high pressure across the Bay is obliterated, and the south-east trade, crossing the line, and curving round, flows on uninterrupted as the south-west monsoon proper of Indian seas. In this season storms are confined to the northern parts of the Bay, and are always preceded, as in all other cases, by an increase of pressure to the northwards which forces back the line of low pressure over the northern parts of the Bay.

It has often been remarked that the storms which visit the shores of Bengal during the period of change from the north-east to the south-west monsoon do not usually possess the same violence as the storms of October, and seldom travel far inland. The explanations of these facts are, I think, to be derived from the different circumstances under which the storms are generated, and from the different conditions of humidity over the land at the two periods. At the close of the rainy season in October the amount of vapour in the atmosphere over Bengal is very great, whereas at the end of the hot season it is comparatively small. Thus the supply of vapour, which appears necessary to support all hurricanes, soon ceases as the storm progresses inland in the latter season. With respect to the comparative violence of the storms, it would appear from what has been said that those generated in the north of the Bay in May would have but a limited amount of vapour to feed them. In the case of the storms in June and July the supply of vapour from the south would not be wanting, although that from the north would still be deficient. However, one of the conflicting winds—that from the north-east—would in this case be much less vigorous, most of its course being over the land.

About the cause of the motion of a vortex when once formed, and the reason why it pursues a curvilinear path resembling a parabola, I have very little to say. It seems improbable, indeed, that any very complete explanation of all the phenomena of cyclones will ever be possible until more is known of the courses of the upper currents of the atmosphere and of the nature of the ordinary waves of barometric pressure. It would appear, however, to be not improbable that the curvilinear path of cyclones is due to a combination of two motions, the one a general progression of a trough of low pressure northwards, and the other the motion of the vortex along this trough. The latter motion seems to be caused by the restoration of equillibrium commencing at first on the eastern side and propagated thence westwards as one focus of depression is filled up and another formed further ahead. The former motion is probably analogous to the motions of ordinary waves of barometric pressure, about the cause of which we know little or nothing.

Summary of the Course of the Cyclone.—The general course of the storm and the area which it affected will be best understood by consulting the map given on Plate II. The diameter of the body of the storm was probably larger at sea, as would be expected, than when it was passing over the land. As it moved northwards, it not only contracted in diameter, but also rapidly decreased in violence. The mean path of the centre at sea was about N.N.W., but it became more northerly as it approached the land. Its rate of motion, which was not more than 6 or 7 miles an hour in the Bay, also increased, and passing over the Sandheads was between 10 and 11 miles an hour. On reaching land, however, the storm seems to have been suddenly checked in its course, and it passed very slowly over the southern parts of the Midnapore district. North of the town of Midnapore, and before it reached Jehanabad, the mean path seems to have turned rather sharply round to N.N.E., and the velocity of propagation again increased to about 10 miles an hour as it passed Burdwan. From this place the course was again northerly, but the path turned off to N.N.E., and finally to N.E., as the centre passed over Berhampore and Rampore Beauleah. The velocity of propagation also again diminished to about 7 miles an hour. The diameter of the area over which the wind blew with hurricane force probably never exceeded 50 miles. Through the Balasore and Midnapore districts, the western limit of the hurricane was clearly defined, and the force of the wind appears to have been greatest near the western

border. On the eastern side there was no such clear line of demarcation between the hurricane and the gale outside. The force of the wind appears to have gradually diminished from a hurricane near the central line to a moderate gale at a distance of about 50 miles. After passing Burdwan the storm diminished rapidly in violence, and even before it had reached this place it seems to have broken up into separate vortices, moving very irregularly. However, the general progression of the storm is traceable as far as the Garo Hills in Assam, over which it finally broke up.

Rainfall during the Storm.—Not the least remarkable of the meteorological phenomena which accompany a cyclone is the heavy rainfall along and near its track. The area of Bengal which was affected by the storm and its progress on the 15th, 16th, and the morning of the 17th might be determined with some accuracy from the rainfall given in table V, Section I, for the above dates. The most remarkable falls were at Midnapore, 10·27 inches, at Bood-bood, 8·4 inches, and at Lalgolla, in Moorshedabad, where the almost incredible fall of 16·3 inches was measured on the 16th. Further northwards at Rungpore 6·97 inches fell on the 17th. All these places were on the west of the cyclone's path. At Burdwan the rainfall during the storm was 7·43 inches and at Berhampore 5·93 inches. On the eastern side at Contai 9 inches was measured.

Storm-wave.—The centre of the storm passed the mouth of the Hooghly just before the period of low tide, and it was only over a portion of the Contai sub-division that the horrors of devastation caused by the cyclone were aggravated by inundation from the sea. A chart of tidal observations in the Hooghly, forwarded to me by the Superintending Engineer, South-West Circle, shows that at Diamond Harbour the water at 7 P.M. of the 15th was 16 feet above the level at the same hour of the preceding day and about three feet above the last high tide. Were it not for the storm-wave it would have been low tide at Diamond Harbour between 8 and 9 P.M. of the 15th. At Fort Gloster and at Kidderpore the effects of the storm-wave were similar, but less strongly marked. It was at its maximum at the former place a little before 9 P.M., and at the latter about half an hour later, and at both places about an hour and a half before the time of low tide.

Loss of Life.—Of the loss of life in country vessels and small craft at sea and in the river I have no information. The ship *Evening Star* was wrecked in Saugor roads; and out of 44 souls on board, including the pilot in charge, Mr. Chitty, the master, Mr. Wales, and five European passengers, only 13 lascars were saved. The ship *Grand Duchess* was wrecked in the Eastern Channel, and all on board, including Mr. Branch Pilot Bond, who was in pilotage charge, and Mr. Fox, of the Pilot Service, were lost. A summary of the loss of life on land is shown in the following table:—

Balasore district	... ...	200	(estimated.)
Midnapore „	... ...	3,049	(reported.)
Hooghly „	... ...	9	„
Burdwan „	... ...	99	„
Nuddea „	... ...	4	„
Moorshedabad „	... ...	27	„
Rajshahye „	... ...	4	„
Total	...	3,392	

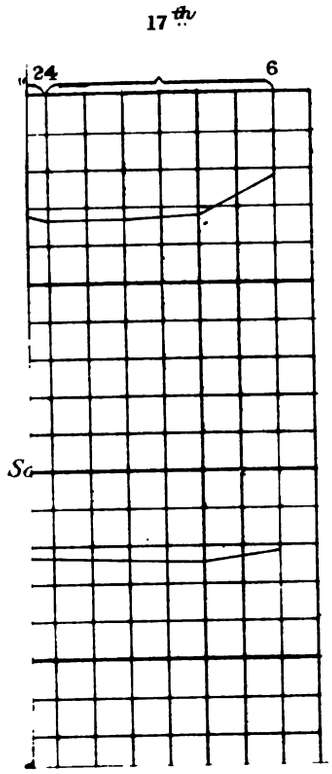
It is probable, however, as represented by the district officers, that the reported loss of life fell far short of the reality.

DESCRIPTION OF THE PLATES.

PLATE I.—Shows the barometric curves from the morning of the 13th to the morning of the 17th October as registered on board the *Coleroon* Pilot Vessel and at Saugor Island, Calcutta, Burdwan, and Berhampore. Also the barometric curve at Contai during the passage of the cyclone. The barometric observations as here plotted are not reduced to sea-level, and the Contai aneroid, which evidently reads somewhat too high, has not been compared with the standard. These curves are, however, only intended to show variations of pressure at each place before and after the cyclone and during its passage.

PLATE II.—Shows the mean track of the storm from the place of its formation to the place where it finally disappeared and the area affected by it. Synchronous barometric and wind observations at 10 A.M. and 4 P.M. of the 15th and the approximate positions of the vortex at the above hours are also exhibited. The uncoloured belt in the centre of the storm's track represents approximately the mean path of the vortex (or succession of vortices), and the outside parallel lines are intended to show roughly the approximate boundaries of the part of the storm inside which the wind blew with hurricane force. From Burdwan the unshaded belt cannot be regarded as showing accurately the mean path of the different vortices which were formed, but rather the mean path of the centre of the progressive storm as a whole. Beyond this locality, even near the central line, the force of the wind was less than that in a hurricane, and gradually diminished as the storm moved further northwards.

The synchronous barometric and wind observations at 10 A.M. of the 15th are shown in red and those at 4 P.M. in blue. The atmospheric pressures are all reduced to sea-level and are comparable with each other.



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FINANCIAL DEPARTMENT.

INDUSTRY AND SCIENCE.

CALCUTTA, THE 31ST MAY 1875.

RESOLUTION.

READ—

Report of the Midnapore and Burdwan Cyclone of the 15th and 16th October 1874, by W. G. Willson, Esq., Officiating Meteorological Reporter to the Government of Bengal.

THERE is no evidence, it seems, of the existence of the cyclone before the night of the 13th October, and Mr. Willson surmises that it had its origin in 16° to 17° north, between the parallels 89° 30′ and 90° 30′ east. It appears that from noon of the 12th October, strong squally north-easterly winds set in about 17° north, extending by noon of the next day 140 miles north, while wet squally gales from west-south-west were blowing at the same time a degree or two to the south. Were these observations absolutely verified, they would afford some confirmation to the theory that these storms in the Bay of Bengal are generated, like the hurricanes in the Indian Ocean, in the belt lying between two parallel atmospheric currents flowing in opposite directions, implying the existence of comparatively high atmospheric pressures to the south and north of the belt. It is shewn that these disturbances existed in the present case; the pressure to the southward in the neighbourhood of Port Blair, and to the northward over Bengal, being above the mean immediately before the storm, and to the southward very abnormally so.

Very little information, unfortunately, was to be obtained by Mr. Willson concerning the progress of the cyclone up the Bay, four or five ships only having been in its neighbourhood until it arrived near the Sandheads; and of these few, three were Arab craft, whose logs are principally taken up with the story of their prayers, the phantom ships they saw, and the "devils on their main-masts." Information, more or less valuable, however, was obtained from the logs of the *Ireshope*, the *Patrie*, the *Udston*, the S.S. *Scotia* and *Sirius*.

The data submitted by the Marine authorities from the pilot vessels, the floating-light ships on the various stations, the *Mistley Hall* in the Roads, the American schooner *Susan E. Vorhes* in Diamond Harbour, and the land observations recorded at False Point, Saugor Island, and by Mr. Taylor at Contai, furnished Mr. Willson with abundant material for tracing the course of the cyclone when it reached the coast, to the examination and discussion of which he devotes the third section of the report; and the Master Attendant will be good enough to direct the careful attention of his establishment to this important record.

The centre of the storm passed the mouth of the Hooghly just before low tide, and it was happily only over a portion of the Contai sub-division that the effects of the cyclone were aggravated by the inundation of the storm-wave from the sea. The *Evening Star* was wrecked in Saugor Roads under distressing circumstances, only 13 lascars being saved out of 44 persons on board, including the pilot Mr. Chitty, the Master, and five European passengers. The *Grand Duchess* was wrecked in the Eastern Channel, and all on board were lost, including Mr. Branch Pilot Bond, who was in charge, and Mr. Fox, of the same service. The Lieutenant-Governor regrets very deeply to have to record these casualties, and would express his sympathy with the bereaved relatives of the brave men who thus lost their lives.

Upon the occurrence of the storm, a circular was addressed to the District Officers of the Presidency, Orissa, Burdwan, Rajshahye, and Chota Nagpore Divisions, desiring them to report any particulars of the cyclone, or meteorological observations connected therewith, that might have been recorded in their neighbourhood, or have reached their offices; and they were particularly desired to note, if possible, the force and direction of the wind, the course of the storm's progress, and the barometric readings before, during, and after its passage, with any other phenomena attending it that might have been observed. The valuable records that were at once submitted from almost every district which the cyclone traversed, were made over to Mr. Willson, and that officer's report shews what important uses the information thus communicated has served.

Two of the Government meteorological observatories were in the path of the centre of the storm. From one of these observatories (Berhampore) a valuable account was received; but Dr. French, the Civil Surgeon, was unfortunately absent from the other (Burdwan) on duty when the storm occurred, and was consequently unable to contribute more than a series of aneroid readings from that station. The only parts of Orissa which suffered from the cyclone were the two northernmost stations of the Balasore district, Baliapal and Jellasore, where its ravages were very disastrous. The storm raged from noon to midnight of the 15th. From Baliapal to Bhograi the country presented a scene of desolation, almost every house being destroyed, and hardly a tree standing erect. Half the cattle are estimated to have been destroyed by the storm, and 200 lives lost. Its chief violence, however, was spent upon Midnapore, where the intensity of the storm is reported to have far exceeded that of the cyclone of 1864. The loss of life in the town itself was very lamentable, which amounted in the whole district to 3,049. The labours of years in the way of arboriculture were destroyed in a single night, and 17,500 cattle are reported to have perished. The Hooghly district escaped with the exception of a small part only, but five deaths are unfortunately recorded.

Twenty-nine deaths are reported from Burdwan, twenty-seven in the Moorshedabad district, nine in Hooghly, seven in Nuddea, and four in Rajshahye. In Midnapore, the hurricane was attended by the extraordinary rainfall of 10·27 inches. At Moorshedabad the almost incredible fall of 16·3 inches was measured on the 16th; at Burdwan, 7·43 inches during the storm; at Berhampore, 5·93; and as far north as Rungpore, 6·97.

The Burdwan district suffered severely, and upwards of 21,000 houses were destroyed. Near the Kanoo station the down passenger-train was brought to a dead stand by the violence of the wind, and finally blown over upon the up-line. In the Moorshedabad district the storm was at its highest between 8 A.M. and 4 P.M. of the 16th. The cyclone seems to have traversed the whole length of the district and, crossing the Ganges, passed into Rajshahye, where it finally spent itself.

A very melancholy loss of life thus attended the cyclone: 3,392 persons are reported to have been killed thereby on land, while all the district officers express their fear that this number falls far short of the actual deaths.

In the concluding section of his report (V), Mr. Willson notices the two theories that prevail concerning the origin of these storms, their prognostics, their form, and probable mode of formation. The form of the cyclone, Mr. Willson says, is a question which is engaging considerable attention amongst meteorologists, and that part of the section which deals with this subject, with some remarks on weather indications and the behaviour of the barometer at the Sandheads and the north of the Bay immediately before their occurrence will, the Lieutenant-Governor thinks, be of special value to mariners. Mr. Willson's views concerning the formation of these terrible storms are supported by great authorities, and will doubtless be read with much interest in the scientific world.

"Given," says Mr. Willson, "the existence beforehand of two nearly opposite colliding wind-currents, and hence by necessity an ascending current in the belt between them, the production of a cyclone can be accounted for on dynamical principles." The Lieutenant-Governor observes that Mr. Blanford, who is one of the highest authorities on Indian meteorology, does not think this theory of the formation of these storms applicable to the cyclones of the Bay, but believes a local atmospheric depression to be their primary cause, and that it is only when the winds have commenced to circulate round this area that the north-easterly current sets to the northward; and Mr. Blanford attributes the depression to a high local temperature possibly produced by hot marine currents from the south. His Honor simply notices the two theories as affecting a question of great public interest. Either of them, according to Mr. Willson, would account for the origin of these storms; but it is said to be an important fact in connection with the evidence in favour of the theory of opposite currents that before a cyclone, and during its approach, north-easterly winds prevail to the north of the storm over many degrees of longitude, and that there seems to be no marked tendency of the winds to a circular path until the cyclone is close at hand.

Mr. Willson directs attention to the uncertainty, at this season of the year, of the weather indications at Calcutta and Saugor Island as to the approach of these storms; and the observations by which he illustrates this uncertainty in the last section of the Report will, the Lieutenant-Governor has no doubt, be carefully noted by the Marine authorities.

There appears to be an important distinction between the storms which visit the Bay at the end of the south-west monsoon and those which sometimes attend its commencement. The former are usually generated, it seems, in the eastern part of the Bay, a little north of the Andamans, while the latter appear to take their rise in the northern part of the Bay, the barometer falling steadily and considerably for days before their occurrence. On the other hand, the barometer gives little indication of the approach of a cyclone in October until it is close at hand. Thus the cyclone of October last was remarkable for the lateness of the warning given by the barometer, although its vortex was of comparatively large diameter, and the barometric depression in the centre of its path as great probably as any on record. Mr. Willson's remarks on the management of the pilot brigs in the storm shew that their Commanders seem to have been unable to judge accurately the distance of the storm, being misled by the slowness of the barometer to indicate that they were actually within the radius of the hurricane, when they attempted, too late, to get out of its path.

This report will be circulated to all those officers for their careful study and for record.

The alarm and injury caused by the storm in the Midnapore district were so great, that an appeal was made by the District Famine Relief Committee to the Central Committee in Calcutta for a grant of two lakhs of rupees for relief of the sufferers. A sum of one lakh of rupees was at once sent to them, and a promise of another lakh held out, if further help were required; a telegram having been sent to London, and permission obtained from the Lord Mayor to divert this munificent contribution to the relief of the people, who were already in extremity from the dearth of the previous twelve months. It was found, however, that the further sum was not required.

The Lieutenant-Governor's thanks are due to Mr. Willson for this very interesting report, which is the second memoir of the kind for which the Bengal Government is indebted to him, the cyclone of June 1872 having occurred while Mr. Willson was officiating as Meteorological Reporter to this Government. The thanks of the Lieutenant-Governor are also due to the Commissioner of Burdwan, to Mr. Harrison, the Collector of Midnapore, and the other district officers who responded so promptly, and with so much care, to the call made upon them for such data as they were able to furnish for the preparation of this report, for the early submission of which, considering the

complexity of the task, and the great obscurity in which all meteorological researches are still involved, the Lieutenant-Governor desires especially to thank Mr. Willson.

By order of the Lieutenant-Governor of Bengal.

R. KNIGHT,

Asst. Secy. to the Government of Bengal.

No. 1817.

COPY of this Resolution and of the Report, with 100 spare copies of each, forwarded to the Master Attendant, for information and distribution to officers in his Department.

No. 1818.

COPY of this Resolution and of the Report, with 25 spare copies of each, forwarded to all Commissioners for information and distribution to district and sub-divisional officers.

By order of the Lieutenant-Governor of Bengal.

R. KNIGHT,

Asst. Secy. to the Government of Bengal.

CALCUTTA,
The 31st May 1875.

REPORT

OF THE

MIDNAPORE AND BURDWAN CYCLONE

OF THE

15TH AND 16TH OF OCTOBER 1874.

BY

W. G. WILLSON, M.A., L.C.E.,

Offg. Meteorological Reporter to the Govt. of Bengal.

Calcutta:

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